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A PROPOSAL FOR THE FUTURE OF URBAN LIGHTING: RETHINKING NIGHT SHADES

MBDESIGN.

MASTER'S DEGREE IN ADVANCED STUDIES IN DESIGN-BARCELONA (UPC /UB)
CONTEMPORARY DESIGN

Ursula Eyzaguirre Kouri

Director:

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June 2019

To my family and friends for the unconditional support

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Abstract

Nowadays light plays a vital role in our daily life. I believe that enlightenment is fundamental for our existence, since it is linked to cultural, economic, social and political aspects of our global society. More than half of the world's population currently lives in cities and the United Nations estimates that this figure will increase to 70% by 2050 (UN, 2018). Although the trend we are facing is the growing migration to the city, the answers we have been giving to the phenomenon of urbanization has not been up to the task, we are not exploiting the maximum potential of the cities.

When night falls, the city shuts down, activity decreases and commercial and office premises close their doors, which means that activities in the public spaces of the urban centers fall. The night presents new challenges for cities around the world, whether for reasons of safety or lack of visibility or attraction. Although the urban transformation of the last 20 years has been overwhelming, this has not been taken into account with real importance.

The main motivation of this project is to give a comprehensive approach to strategic planning and lighting design for the night. A holistic approach to urban lighting could help create attractive, safe and inclusive places for the entire population. Urban lighting must be rethought beyond a functional element for the safety or visibility of the city, it must be recognized as an opportunity and fundamental solution to improve the quality of life of urban citizens. Considered correctly, lighting can positively impact the overall design of our cities, reinforcing urban design.

The main focus of the project is urban lighting as the tool through which cultural experiences can be enhanced and social interaction encouraged. At present, there is an infinity of technological resources that have opened a wide range of opportunities to innovate in the area of lighting. However, despite technological innovations, such as LEDs, I believe that the future of urban lighting can be more exciting and must be in direct relation to the needs of the population. The cities that serve the population are understood as complex interactive systems.

Urban lighting is not the end in itself; but it is a means by which we can improve the conditions of habitability of the city by improving its social and economic dynamics. The objective is to propose a planning and design approach for urban lighting focused on the real needs of the user, through new interactive technologies.

Key words: future design, smart city, urban spaces, urban lighting, interactive technologies

1. URBAN LIGHTING



1.1. State of art

Urban lighting is an issue that involves the challenges of the cities of the future, of smart cities. In 2015, the United Nations promoted the debate on the relationship between social development and the efficient application of urban lighting infrastructure. As part of the global agenda, new solutions for urban lighting are sought, which must be based on a creative design in the conceptual area, be efficient in energy and comfortable for citizens.

It is in this sense that urban lighting offers an opportunity to address economic, environmental and social problems, and can help us to re-imagine the use and function of our cities at night.

Currently cities consume 70% of the world's energy supply, a figure that experts say will increase over time. Also, forms of artificial lighting, including lighting inside buildings, currently represent 19% of the world's electricity consumption. It is estimated that by the year 2030, the demand for artificial lighting will increase by 80% worldwide, compared to the levels of 2006. Lighting systems only control the market is estimated to grow by 20% per year between 2012 and 2020, driven by a focus on more energy-efficient technologies and the adoption of intelligent LED systems (Philips, 2012).

Despite the continuous technological advances, access to light is not available to all citizens, in many areas of cities there is no proper lighting and this harms the use of public space. As David Nye expressed it in his prologue to *Cities of Light: two centuries of urban illumination*:

“satellite photos suggest the extent of urban lighting, but do not reveal the symbolic meanings or the socio-economic forces at work in electrification...The homogeneity of the night satellite proves an illusion. It is a useful but incomplete fiction” (Nye, 2015).

With all this information it can be considered that, with the latest generation technologies, interesting economic and ecological savings can be achieved. The concept of intelligent lighting is still incipient, however, it is due to the great benefits that will be implemented in many cities, optimized by automation and intelligent control systems, also taking advantage of

the development of the “Internet of things”. Thanks to these innovations can generate significant savings are possible, on average 40%, simply switching to energy-efficient lighting technologies such as LED. Globally, these savings amount to € 128 billion in reduced electricity costs, 670 million tons of CO₂ (Philips, 2012).

The lighting must be dynamic according to human needs, it must also be efficient and automated to be sustainable and economical. The objective of the project is to determine how the lighting of the city of the future looks, starting from imagining new forms of lighting based on interactive technologies that will improve the urban experience in the urban space. The research explores the future of cities at night, and the role that lighting solutions can play in achieving healthy, inclusive and sustainable urban lifestyles. It focuses on the human factor and ways to improve the experience and use of public space during the hours of darkness.

Figure 1. New York Photography by Majestic Flights, 2018.



1.2. The importance of Urban Lighting

Over the years urban lighting has followed a parallel evolution to that of cities. Since ancient times, man has used different devices and inventions to generate light, and the urban development of cities stimulates the need to propose new and innovative inventions that are determined by the evolution of human needs. The use of artificial lighting began when the man learned to control the fire and was able to move it to the cave that allowed to see what was happening around. At this time the first luminary was born.

The cities have been baked around the experience of the day, leaving aside the night design. This difference between day and night city can be linked to the fact that most economic activities took place during sunny hours; However, it was with the arrival of the oil lamp, gas lighting, electricity and the invention of the incandescent bulb that the doors opened to expand human activities in the hours after darkness.

Urban lighting is a substantial part of the current urban landscape; you cannot understand the way of life today without external lighting. The development has gone from the first installations that were loose points of light to the new systems equipped with the latest technology, which allow to manage globally and effectively the lighting of cities. The lighting was conceived with the aim of maintaining human activity at night in the city.

Cities are very complex living systems, which present problems of habitability, since in many areas the streets have been left aside with situations that are so characteristic of urban public space as play, meeting, contemplation or the relationship between citizens. This is how the current paradigm leads us to think of a 24h city that allows experiencing total urban life at all times of the day. There is an important percentage of the social and economic life that now takes place in the hours after nightfall, and it is precisely this tendency which is changing the perception of day and night, as understanding the importance and the distinctive character of the different shades of the night, from dusk to dawn, we stop seeing the light as a purely functional element, it becomes something much more emotional, we associate it with the different activities that we carry out, whether the social extension after

the workday, go road to the cinema, theater, ballet, concert or opera.

A considerable amount of activities takes place after darkness, such as the industries that operate at night intervals, which requires adequate urban accessibility and mobility for those who work at night. 18% of the working population of China, 19% of the United Kingdom and 27% of the active population of the United States perform some type of night work during the hours of 10:00 to 6:00 (Lee, McCann and Messenger, 2007). Thanks to these nocturnal activities, many cities already understand the economic implications of a thriving nocturnal economy. In 2009, it was estimated that the UK night economy would generate 27% of total urban billing, while Sydney could generate \$ 2.7 billion in economic benefits with only \$ 127 million in night-time management expenses. When designing for the night, we need to consider the need for streets and places to allow a complex set of economic and social uses, and see lighting as the facilitator of thriving urban economies.

Based on the aforementioned, it can be said that the concept of living city takes more value and determines the guideline for the future of urban lighting that becomes more relevant and significant in this context: the lighting of bus stops that improves the health and well-being of passengers; the streetlights in the streets that help to have a better visibility of the road, the interactive facilities that encourage interaction with the pedestrian, in summary all these systems not only provide a generic lighting in the functional sense but go further and stimulate the activities social networks in the urban space, generating vital and attractive urban environments. Good lighting allows a better visualization of the city and increases the quality of life of people thanks to the habitable that urban spaces become and the feeling of security that they produce due to the integration of the dynamisms of the city.

Figure 2. Photography of Nanjing Road in Shanghai by Tony Shi, 2018.



In the future, cities will adopt a holistic approach to the 24-hour cycle, a city in tune with natural dynamics and the ever-changing personal and public needs and aspirations of the population. Current advances in lighting technologies, from smart LEDs to OLEDs (organic light emitting diodes), are fostering a new trend of innovation that has the potential to transform once again the way humans use and experience them. spaces in the hours of darkness (The Columbia Encyclopedia, 2014). Intelligent systems and integration in urban design can allow lighting that responds to specific situations and contexts, helping to design inclusive and more livable urban environments.

Figure 3. Photography of Vehicles Stopping In Front Of Pedestrian Lane in Chicago by Benjamin Cruz 2019.



1.3. Human Activity and Spaces at Night

Human needs are the driving force for design decisions and night design is the perfect scenario to give meaningful solutions to the problems that cities currently suffer. The night is a scene of many activities and dynamics, as a space for enjoyment, participation and fun in public spaces. These nocturnal activities depend on demographic conditions, climate and geographic context, and vary greatly throughout the shadows of the night.

The public domain is defined as those non-private sectors or urban areas in which people relate to others and tend to be personally unknown or only categorically known to each other, this atmosphere allows humans that the interaction takes place (Lofland, 1998). The considerations of the public sphere are a powerful tool in the design of cities that work for their inhabitants. To achieve lively and functional public spaces, we need to better understand the way in which the population uses the city in different ways.

The integral urban design gives control of the urban environment to the people, allows citizens to experience social life in a public square only through the use of their voices. There are several projects that combine interactive technologies that identify human dynamics and establish a direct relationship with the user, these lighting installations reveal new definitions of space and allow people to interact dynamically with each other and with the environment.

Public interaction with urban lighting can also focus on the planning stage. In New York, proposals for a comprehensive lighting strategy were requested for two main street corridors, the ARUP office proposed a participatory process that would instruct stakeholders and help develop a comprehensive plan. There is also the NightSeeing program, which aims to raise awareness about light and shadow in nightlife in cities around the world, as well as provide an overview of lighting theory to the general public and design professionals. equal (Schwendinger, 2009). This program allowed to experience the area at night, people highlighted a particular interest in enjoying the streets at night: through food trucks, shopping, persistence and appreciation of color and friendships. Thanks to this specific lighting project, the safety and enjoyment of the city was clarified. In this project, creative solutions

were implemented that responded to the context and helped to integrate the population with the urban lighting plan.

The company ARUP was also responsible for the redesign for Bradford City Park in the United Kingdom and as part of the proposal focused on the design of balanced lighting to offer a flexible public space and at the same time maintain the functional requirements of a major park in the city. The success of the project lies in the design of a pleasant space that allows a wide range of events, activities and social interactions. The public space is designed for pedestrian use both day and night. Within the proposal, lighting systems were proposed in order to create a functional but fun nightlife that helps to tour the park with greater emphasis on the main routes and directional decision points. Laser lighting equipment and interactivity sensors were used, the integrated LED sources change the hue of the colors and add a dynamic sensation that gives identity to the public space. The lighting provides a subtle and discreet background to the park, technology was used to avoid excessive lighting of the space and allow interactive color and lighting to become more important. As a result of the proposal City Park has become a vibrant and high-quality space that, especially at night, has changed public interactions and general experience for residents and visitors alike (Arup, 2012)

Figure 4. Inside Out Brandon Many Ribs, Standing Rock Reservation by Dan Nguyen, 2012.



At night, the image of the city we have is created through what is illuminated, the visibility that it generates, which allows us to enjoy and adapt to the nocturnal environment. Light and design are powerful tools to create a pleasant atmosphere for citizens; they shape the sensory experiences of our environment. The development of a successful space is a scenario where people explore. The lighting functions as a background for human activities after dark. Its great value lies in the ability to alter spaces in a positive way, through the design of shadows, colors and intensities. The planning of the lighting generates the creation of prosperous space since different types of light sources are used, from the traditional lighting of lamps to the environmental lighting emitted by other elements such as advertising panels.

Figure 5. City Park Bradford Photography by Arup, 2012.

Figure 6. City Park Bradford Photography by Chris Young, 2016.



1.4. Interactive Lighting Factors

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Figure 7. Van Gogh Bicycle Path by Studio Roose-gaarde, 2015.



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Figure 8. Photography of Metalocus for Llum BCN by Àngel Lader, 2017.

2. RISING NEW TECHNOLOGIES



2.1. Barcelona as a Smart City

The 2030 Agenda for Sustainable Development, aims to carry out a comprehensive plan of action in favor of people, the planet and prosperity. It is considered the greatest challenge in the world to improve the quality of life of the population and convert cities into more inclusive spaces. The new strategy will reactivate the economy and the development of smart, sustainable and inclusive growth. (UN, 2015). This growth will be developed through new innovations that promote a better energy efficiency to achieve more sustainable cities with more inclusive urban environments that raise the quality of exceptional life.

In this context, the concept of Smart City is defined, which refers to a type of urban development based on sustainability, which rescues the objectives of the global agenda. The smart city is an urban area that uses different types of innovative technologies such as electronic sensors (IoT) to collect data and then use this data to manage the different elements of the city efficiently. This includes data collected from citizens, devices and assets that are processed and analyzed to monitor and manage traffic and transport systems, power plants, water supply networks, waste management, crime detection, information systems, schools, libraries, hospitals, and other community services (McLaren and Agyeman, 2015).

The true smart city must be based on the use of network infrastructure to generate social, cultural, economic and environmental development (Hollands, 2008). Although this term is quite new, the idea comes from an evolution of past agendas, which incorporates technology as a support to solve urban problems in a more efficient way, but it is not the solution in itself, its value lies in the results it allows achieve. The concept of smart city provides an innovative and alternative approach to urban planning in relation to sustainability issues. In order to transform urban areas into better places to live, smart cities embody social and environmental capital through the intelligent use of new technologies. (Deakin and Al Waer, 2012).

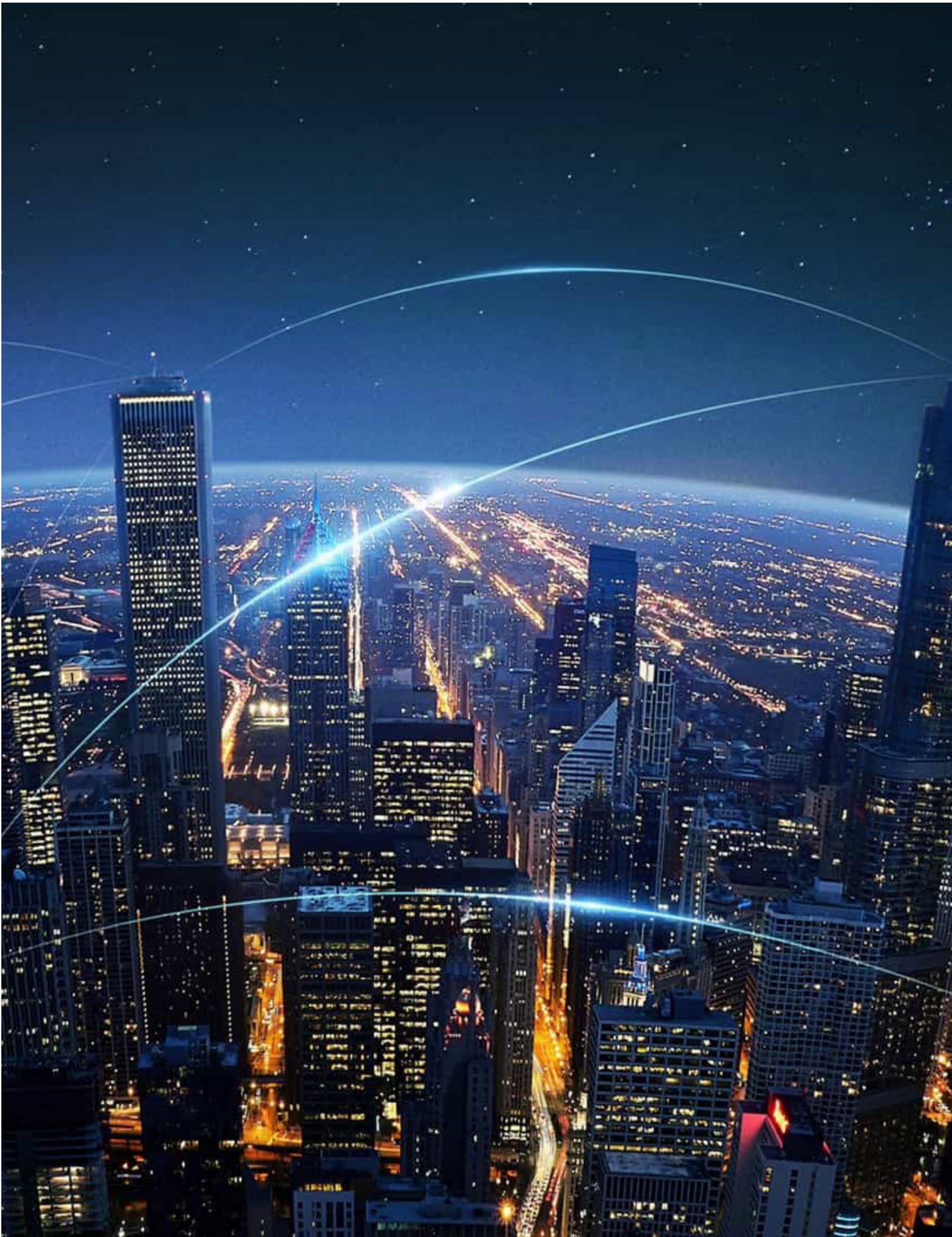
Likewise, the European Innovation Association on Intelligent Cities and Communities, published a Strategic Implementation Plan where the following definition was published:

Cities are becoming more and more of a focal point for our economies and societies at large, particularly because of on-going urbanization, and the trend towards increasingly knowledge intensive economies as well as their growing share of resource consumption and emissions. To meet public policy objectives under these circumstances, cities need to change and develop, but in times of tight budgets this change needs to be achieved in a smart way: our cities need to become 'smart cities'. (EIPSC, 2013)

On the other hand, the upgrade to 5G networks allows a wide variety of applications for smart cities, including intelligent urban lighting, intelligent traffic management and, of course, autonomous cars. 5G technology and the growing development of new technologies is appropriate to put the issue of urban lighting on the table. The fifth generation technology offers a wide range of functions, which are beneficial for all groups of people, including students, professionals (doctors, engineers, teachers, government bodies, administrative bodies, etc.) and even for an ordinary man. In addition to the technical advantages in daily life, the impact would be positive because, for example, it will allow people to connect with multiple services in a more efficient way, such as weather and location conditions, while they are talking to another person.

We are currently facing the confluence of two major trends, on the one hand, the growth of urbanization and on the other the rapid evolution of information technology. Cities such as Barcelona face the urgent need to create new urban innovation strategies that promote the development of the new economy and that entail great social benefits at the same time. That is why Barcelona City Council joins the "Smart City" plan and defines it as "a new concept that defines a city that works to improve the quality of life of its citizens by guaranteeing sustainable social, economic and urban development. A smart city is based on the use and modernization of new information technologies and the Internet of Things (IoT) to provide a more efficient management of the services and resources of the city "(Ajuntament de Barcelona, 2016).

Figure 9. Aerial View Of Wonderful Barcelona by Amos Chaple, 2014.



According to the Pla “Barcelona Ciutat Digital”, Barcelona aims to go beyond the concept of Smart City or and take full advantage of the opportunities offered by the technologies based on data and its great power of transformation, maintaining the commitment to meet the needs of people from a technological approach focused on networks of sensors, gadgets and connectivity. Public investment is focused on digital public infrastructures that improve public services and are the gateway to a more sustainable society and economy.

The Digital Agenda of Barcelona seeks to create a new and powerful vision in which technology is an instrument for the empowerment of people and the transformation of the city. In an inclusive city, with open data and public information infrastructures, with better and more affordable public services and a higher quality of life. This is how Barcelona became a pioneer in the implementation of the Smart City idea and aspires to lead the trend towards technological sovereignty by becoming a self-sufficient city, with productive neighborhoods, living at a human speed and producing zero emissions (Barcelona Ciudad Digital, 2015).

This vision implies finding a better quality of life for citizens through the use and integration of technology and offering an efficient management of the city’s services, as well as facilitating the interaction of its citizens.

Figure 10. Blockchain The Decentralized Government of Smart Cities by IE Insights, 2018.



2.2. Night Life at Barcelona

The nocturnal landscapes and their image, the correct way to illuminate them, the new urban tendencies, the sustainability, are themes that are part of the current problems. This project seeks to study lighting as an essential element, characterizer and coordinator of night landscapes and the image of the city, understanding the city as a great system of relationships and the night as a landscape that does not depend on the daytime image, but rather It has its own identity, criteria and language (Pedomo and Muros, 2013)

The night-time image highlights the relationships between individuals in cities and lighting is the tool of urban comprehension as well as externalizing identity and multi-functional character. Man has always tried to dominate natural conditions, has tried to understand the night and find a way to inhabit it, after the arrival of electricity, as explained in the previous chapter, light became the transforming element. Illumination not only implied its implementation within the architectural designs, but it also significantly influenced the lifestyle of the citizens. It transformed the urban life of all citizens, extended the active hours in which people were able to attend shows, parks, restaurants, etc.

According to Matthias Armengaud:

“Is the night an indeterminate contemporary landscape to be invented? [...] What is a specifically nocturnal public space? On the basis of which principle does one develop a project? If night means the ephemeral, the fragile, the spontaneous, how does one construct this element without distorting it? To observe the cityscape by night means to ask oneself about nocturnal design values [...] (the) temporary night is the urban laboratory of many cities.” (Armengaud, Armengaud and Cianchetta, 2009)

Likewise, Rem Koolhaas dedicates an entire chapter of his book *Delirious New York* to the study of Coney Island Park, where he recovers how this purely nocturnal space transformed the image of the city. “With the arrival of the night a fantastic city of fire suddenly rises from the ocean to the sky. Millions of luminous points shine in the darkness creating a luminous outline on the dark background of the sky and drawing miraculous castles, palaces and temples.”

Professionals from the Department of Geography and the Institute of Science and Environmental Technology of the Universitat Autònoma de Barcelona (ICTA-UAB) have analyzed and made the first map of the neighborhoods with the most urban life in Barcelona. The study that synthesizes and applies the ideas of Jane Jacobs on how cities should be configured to have life in their streets. In this way, one of the conclusions is that 25% of the areas of Barcelona have a high vitality, 35% moderate and 40% low.

In the case of Barcelona, you can find environments with a high vitality and areas with less urban life. For example, in the downtown neighborhoods such as La Rambla, the Gothic Quarter or El Raval present a high level of urban activity; Contrary to areas such as the Olympic Village, University Zone that have a very low level of street activity. In this sense, the mobility index and urban activities are due to the phenomenon of tourism that have turned these neighborhoods into scenarios of overpopulation and gentrification.

Thinking about functional, ornamental and commercial illumination in historical centers is a necessity in the current circumstances. The sustainable development of our cities demands it, the good use of economic resources, the saving of energy improving the installations of the lighting and the putting in value of the city as cultural milestone of all the citizens. In Barcelona, the trend is to reinforce pedestrian mobility and the specialization of pedestrian routes, which promotes numerous relationships in the night landscape. The best-lit areas within the urban structure of Barcelona are the historic center and areas where night-time shops are concentrated. What predominates is a lighting based on uses, accessibility, the main axes, the level of economic development in the area, also linked to accessibility.

Figure 11. Photography of Llum BCN by Barcelona Secreta, 2019.



The urban conditions and nocturnal dynamics have modified the traditional model of the city to reconstruct it around axes of mobility supported by trade, connections, information and connection with the network is an act of territorial insertion. The night landscape of Barcelona can be understood at two local and global scales, with the local scale being more neighborhood and the global one linked to the Internet and the Smart City concept. These two scales are the guidelines of urban lighting today require a work and a reflection increasingly specialized and projected towards the future needs of man.

Figure 12. Photography of Silhouette Of People Near Fountain by Francesco Panetta, 2019.

3. RISING NEW TECHNOLOGIES



3.1. Interactive Technologies

Technological advances are redefining the lighting design process, the light sources and the tools with which we design have evolved significantly. Nowadays lighting designers have technological resources as digital elements. These advances have opened up endless opportunities in the conception and execution of lighting systems for our cities. They also present benefits such as the reduction of costs and energy consumption and the control of light pollution.

Projecting the city of the future is a challenge for designers and designers, thinking about the transformation of the urban environment forces us to think about the way of thinking about the lighting of our cities. In this context, many innovative projects have been developed that collect and take advantage of the latest technologies for the design of lighting systems that satisfy not only the needs of ordinary people, but also that meet the emotional expectations of users. The designers put into practice the impact of the digital revolution in the area of lighting.

The lighting needs have varied over the years, originally the lighting was directly related as the methodical installation of streetlights on the roads to ensure correct lighting for the vehicles, which generated a homogeneous lighting. However, major urban changes should motivate revolutionizing the way street lighting is planned in cities. Examining the possible future of urban lighting means analyzing and understanding the changes that cities are experiencing today and, in turn, how these major changes can transform the night city and lead to different ways of thinking about how to illuminate.

In this chapter we will present some examples related to the user experience with new interactive lighting systems, able to benefit the user in personalizing their own adaptive behavior. The objective of these projects is to design original systems that are adaptive to the context in which they are located and that react to the presence of pedestrians and emphasize their presence by illuminating the area they require.

Designers are a powerful driver of technological innovation, as they often require combinations of features and performances that go beyond current technologies (Potts, 2007).

The projects that have been taken as a reference show the ability of professionals to intervene thanks to a wide variety of interactive lighting effects, these speculative scenarios that must be considered to contemplate ways of approaching the problems related to public lighting and indoor environments. illumination.

Finally, it can be affirmed that the ability of designers to visualize the future and propose new concepts and new lighting products help to create a possible intellectual and technical image of the future for the night city, which can improve the quality of life and the experience with the inhabitants of the cities. These proposals then have the unexpected effect of opening new ways of appropriating the night space and encouraging activities for those spaces that nobody had previously foreseen.

Figure 13. High-rise Building during Nighttime by Alex Powell, 2019.



3.1.1. Indianapolis's Tunnel

The Acconci Studio is an architecture and art firm founded by the architects Vito Acconci and Maria Acconci in 1980, the main focus of the study is to develop public space projects through experimental and speculative methods, also relying on public art (Acconci Studio, 2019). The study presented a proposal for the renovation of the Virginia Avenue Garage in Indianapolis. The tunnel is designed primarily for vehicular traffic, it only has a small space for pedestrians and its lighting is strictly functional for automobiles. The renovation project focuses on the recovery of space for pedestrians and cyclists, comprising a set of interventions as defined by architects:

“The passage through the building should be a volume of color, a solid of color. It's a world of its own, a world in itself, separate from the streets outside at either end. Walking, cycling, through the building should be like walking through a solid, it should be like being fixed in color. The color might change during the day, according to the time of day: pink in the morning, for example, becomes purple at noon becomes blue, or blue-green, at night. This world-in-itself keeps its own time, shows its own time in its own way. The color is there to make a heaviness, a thickness, only so that the thickness can be broken. The thickness is pierced through with something, there's a sparkle, it's you that sparkles, walking or cycling through the passage, this tunnel of color. Well no, not really, it's not you: but it's you that sets off the sparkle – a sparkle here, sparkle there, then another sparkle in-between – one sparkle affects the other, pulls the other, like a magnet – a point of sparkle is stretched out into a line of sparkles is stretched out into a network of sparkles. These sparkles are above you, below you, they spread out in front of you, they light your way through the tunnel. The sparkles multiply: it's you who sets them off, only you, but – when another person comes toward you in the opposite direction, when another person passes you, when a car passes by – some of these sparkles, some of these fire-flies, have found a new attractor, they go off in a different direction.” (Design Computing and Cognition '10, 2011)

Through lighting, the project transforms the tunnel into a much more pleasant and attractive environment for passers-by and cyclists and invites them to explore it, thus becoming a vital place in the city. Illumination effects are handled such as uniform coloration through a background and an ambient light, which change according to the time of day gradually and is activated with respect to the movements and perceptions of the presence of people who walk through the tunnel. Likewise, different lighting effects that react through sensors in the presence of pedestrians, cyclists and cars are handled.

Acconci Studio proposes two types of lighting system the first type of can be achieved in a simple and centralized manner, requiring in fact a uniform type of lighting that has a gradual dynamic. In contrast, the second requires a different view in the lighting installation as it is capable of perceiving the presence of pedestrians and other nearby physical entities, since it is equipped with sensors. In addition, it perceives local changes as natural light depending on the hours of the day, equally perceived through sensors. According to the architects, this double lighting system using sensors provides inhomogeneous illumination but according to the needs of passers-by. This is how subsystems interact indirectly with people creating a more vibrant environment and a more complex lighting system based on real needs.

Figure 14. Rendering of Indianapolis's Tunnel by Acconci Studio, 2013.



3.1.2. Kennedy Square

The Department of Architecture, Design and Technology of the Aalborg University developed a full-scale experimental study of an interactive lighting system in Kennedy Square. The experiment investigates how human movement intensities can be used as input to control the illumination of a square in the city of Aalborg in Denmark. The trajectory, the speed and the region of occupation of the people in the square of the town were monitored in real time by computer vision analysis of thermal images of 3 cameras that monitor the square. The results were used to control the illumination of 16 LED RGB lamps controlled by a high DMX that were distributed across the square in an irregular grid.

As part of the proposal, 4 different scenarios were proposed in response to the particular conditions of each moment of the day. The researchers do a monitoring to understand how space is used in terms of occupation of urban space using lighting as a tool. People interact directly and indirectly with the lighting elements, producing a feedback with the monitoring system. The environment becomes more sensitive thanks to the sensors in real time. The results of experiments such as these have a value beyond the aesthetically correct since they serve for the development of better design processes, designers and architects can use this information to propose personalized urban environments.

The square is located at the main train station in the center of the city of Aalborg and serves mainly as a transit space. For the monitoring, three Axis Q-1921-E thermal cameras with a height of 15 meters were used. The cameras captured the movements from the station to the plaza. The streetlights have LED lighting that contains 18 LEDs of 1W, six of each color (RGB), each LED module is connected to a DMX module installed inside the light pole. This module allows a brightness control of each LED color, as well as a unique direction of each lamp. Computer vision processing was carried out at the local level using 3 laptops that, through network communication, provided information on the positions, size and speed of people traveling in the plaza. The response light scenarios were controlled by a central computer and a custom designed interface using a DMX communication (Poulsen, Andersen and Jensen, 2012).

It has two lighting systems an environmental type that is active when no one occupies the space, it is a white illumination evenly distributed in the square. On the other hand, it has another system of effects projected by the lamps that is activated when people enter the space, which ensures a correct lighting according to human needs, the lamps project a RGB LED lighting which is more intense.

As a result, it was concluded that people did not notice that the light changed according to their presence or their activities, it was only when they took distance that they noticed it. Also, the experiment showed that a significant saving of energy can be achieved, a difference of 92% was measured between the light scenario that consumes more and less energy.

Figure 15. Overview of Kennedy square seen from the position of the thermal cameras by Poulsen, Andersen, Jensen, 2012

Figure 16. Illustration White Aura scenario by Poulsen, Andersen, Jensen, 2012



3.1.3. Fiat Lux

A group of professionals from Stanford University, Berkeley and Salesiana Polytechnic have developed a project that mixes the design with IoT interactive lighting systems, focused on the well-being and user experience. They present an interactive system built to offer not only functionality, but also positive emotions. The experiment was carried out in the perimeter area of Casa Peralta, a historic landmark in the city of San Leandro in California. In this context, emotional data was detected by controlling external factors such as pedestrian and vehicular flows, temperature variations and natural lighting levels.

They use a network of passive infrared sensors to provide personalized lighting. They base their interactions on an online estimate of pedestrian linear velocity; and use low-cost commercial high-power flood LED lamps to provide a smooth path of ambient light for walking pedestrians. (Paredes, Ko, Calle Ortiz, Canny, Hartmann, Niemeyer, 2016). It is a generic system that can be applied to any context, linear base lighting is necessary to create a safe environment that allows the visibility of obstacles; On the other hand, sidewalks with spot lighting can increase the perception of pedestrian safety.

A modular lighting platform was designed that allowed them to configure the interactive light arrays, which are individually programmed to respond to pedestrian speed and movement direction. Low cost passive infrared (PIR) sensors covered with a tubular piece were used to reduce the sensitivity angle. The lamps used were LED RGB low cost and weather resistant. This system provides an illumination covers the area of the sidewalk used by pedestrians, tracks the position and direction of pedestrians which produces a positive affective impact of the receptive and anticipated lighting.

The designers focus their research on reducing energy consumption by taking advantage of the energy efficiency of interactivity. The lights waste energy and generate light pollution despite little pedestrian traffic, which is why interactive designs reduce energy consumption by 75% while maintaining a positive effect, in addition to producing pleasant sensations thanks to interactivity with the Lighting system. The research shows the significant relationship between the interactions with urban lights and emotions, the value of the proposal is that it serves as a guide for future designs of lighting systems that are not only efficient, but improve the mood and the Affective state of urban residents.

Figure 17. Photography of Fiat-Lux - Interactive Urban Lights for Combining Positive Emotion and Efficiency by Paredes, Ko, Calle, Canny, Hartmann, Niemeyer, 2016.

Figure 18. Photography of Fiat-Lux - Interactive Urban Lights for Combining Positive Emotion and Efficiency by Paredes, Ko, Calle, Canny, Hartmann, Niemeyer, 2016.



3.1.4. Aura

The Studio Nick Verstand created for the Dutch Design Week 2017 the Aura installation, it is part of the interdisciplinary project We Know How You Feel curated by VPRO Medialab, the project consists of four parts: an exhibition with the audiovisual installation AURA that measures the emotions with three biosensors, an interactive evening of debate, an online game and the CEO of Lieve. Aura is an audiovisual installation that reinterprets the emotions of people to build a composition of pulsating light. During the design week, visitors to the facility were equipped with multiple biosensors that recorded brain waves, heart rate variations and skin reactions.

The visitors interacted freely through the space, while sitting or lying on the floor a musical composition sounded in the background, provoking emotional responses. The emotional data was recorded and analyzed to project in different shapes, colors and light intensities from the top. A light is projected from the ceiling creating a light curtain in the form of a curtain which made visible the emotions of each person.

The artist Nick Verstand developed the scientific system in collaboration with the Organization of Applied Scientific Research of the Netherlands. His intention was to explore more light as a medium, an idea that was promoted by artists such as James Turrell, Anthony McCall and Olafur Eliasson. "Aura is an audiovisual installation that materializes emotions in a physical and perceptible way," he explained.

He also explained:

"It explores how this perceptual process influences the understanding of ourselves and of each other. The installation symbolises the materialisation of internal metaphysical space into external physical space" (Verstand, 2017).

Laser light creates a perceptual architecture in space, modulating through the tension of a physical model of strings. The light is influenced by the gravitational attraction of spatial sound objects through a deep integration in the 4DSOUND engine.

Through diffusers and transmission services, we have the ability to offer increasingly personalized services, based on the real needs of each user. The new technologies allow you to measure emotional data and, therefore, offer you a personal multimedia experience that perfectly adapts to your mood.

Figure 19. Photography of AURA by Hanneke Wetzters and Noortje Knulst, 2017



3.1.5. Forest of Lights

The Japanese architect Sou Fujimoto developed the project commissioned by the company COS, it is an installation within the Cinema Arti in the San Babila district of Milan, an abandoned theater built in the 1930s by the Italian architect Mario Cereghini. It was a collaboration between the fashion company COS and the Japanese architect Sou Fujimoto for the Salone del Mobile 2016 in Milan.

Fujimoto took as his starting point the original of the building so I used projectors to create areas of lights and superimposed shadows, making reference to the theatrical scene. The cone-shaped beams cross the black-toned room, and fade in response to the movement of users. Also added sounds, fog and mirrored walls to create the illusion of an infinite landscape, with the foci that appear as imposing trees.

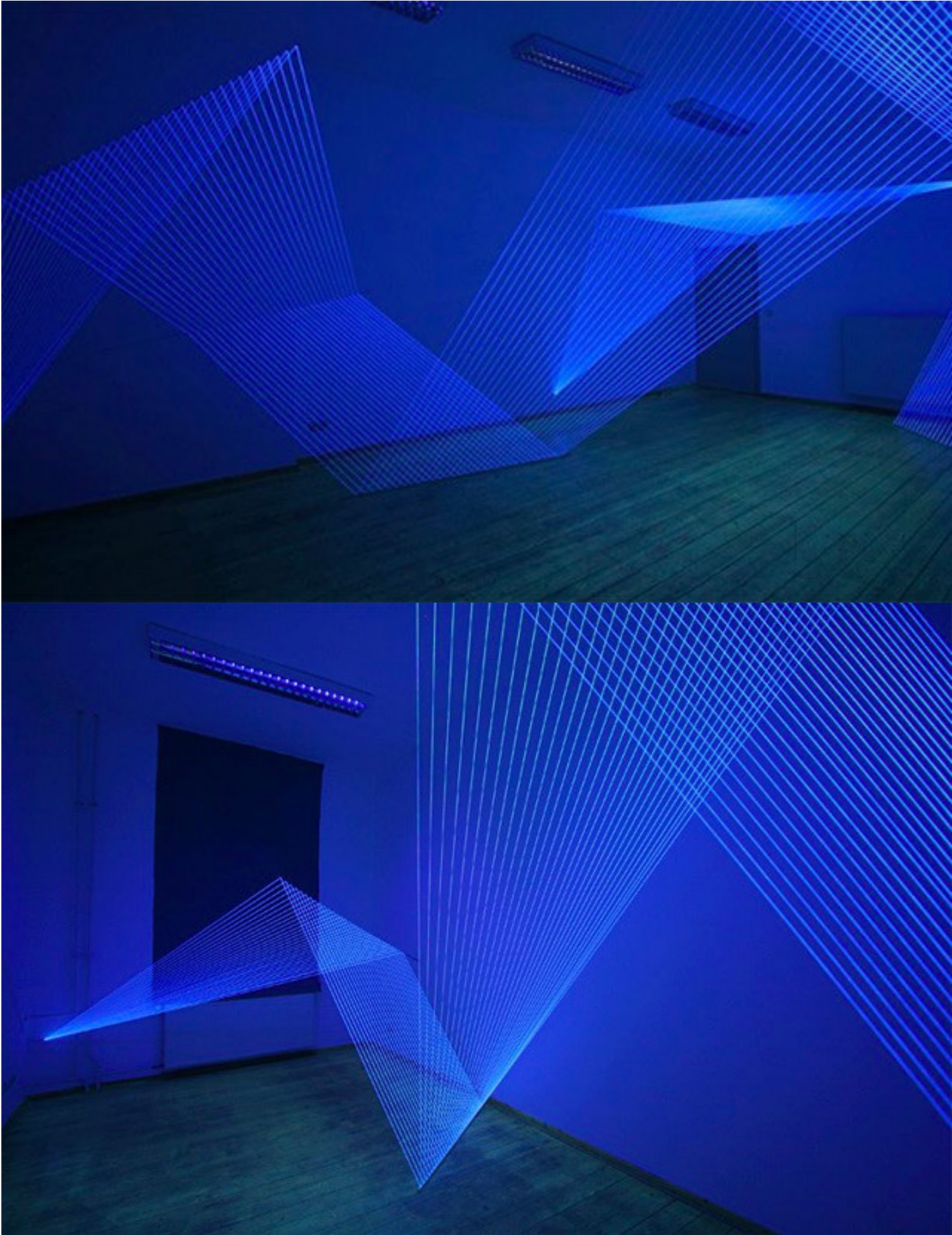
Spotlights, mirrors and specially composed sounds were used to create their “changing forest of light” that responds to the movements of visitors of the COS fashion brand. The lighting is not static, but changing as it varies with the interaction with people.

The architect explains the project:

“In this installation for COS, I conceived a forest of light [...] A forest that consists of countless clouds of light, from a series of spotlights in height, these lights are constantly subjected to the transience of their state and fluidity People meander through this forest, as if attracted by the enchantment of light, light and people interact with each other, (thus) their respective existences define the transition of the other.” (Fujimoto, 2016)

Figure 20. Photography 1 of COS x Sou Fujimoto by Laurian Ghinitoiu, 2016

Figure 21. Photography 4 of COS x Sou Fujimoto by Laurian Ghinitoiu, 2016



3.1.6. UV-Lights

The Korean artist Jeongmoon Choi uses light and thread to create installations that play with aspects of perspective and illusion. With evocations of something produced in a laser light show, its three-dimensional fields formed by light lines are installed in an ultraviolet space to create interactive environments. His work consists of projecting geometry, like architecture, drawing three-dimensional sculptures that shine, as if it were a digital representation.

Its facilities give the sensation of being inhabiting a three-dimensional space of architectural perspective, as if it were a virtual plane of a room. The projected architecture manages to intervene the field and create new geometric spaces, which are illuminated with the aim of creating interactive environments.

Visitors can tour the rooms illuminated by spectacular RGB UV lights. The series of UV LIGHT installations by the artist project abstract forms, creating an illusory geometric main of woven strings that extend throughout the extension of the exhibition site. The facilities create a visual playground full of colors, shapes and an immeasurable vitality for visitors to get lost.

“I realized that the darkening of the room creates a new entity, which additionally leads to a stronger contrast between the drawing and the surrounding space.” (Choi, 2013)

The configuration takes from a moment to several days, during which she imagines movements along the floor, walls and ceiling, sometimes even walking with a rope to follow her path and mark the main points of contact, instead of complete the details. Sketches or extensive plans.

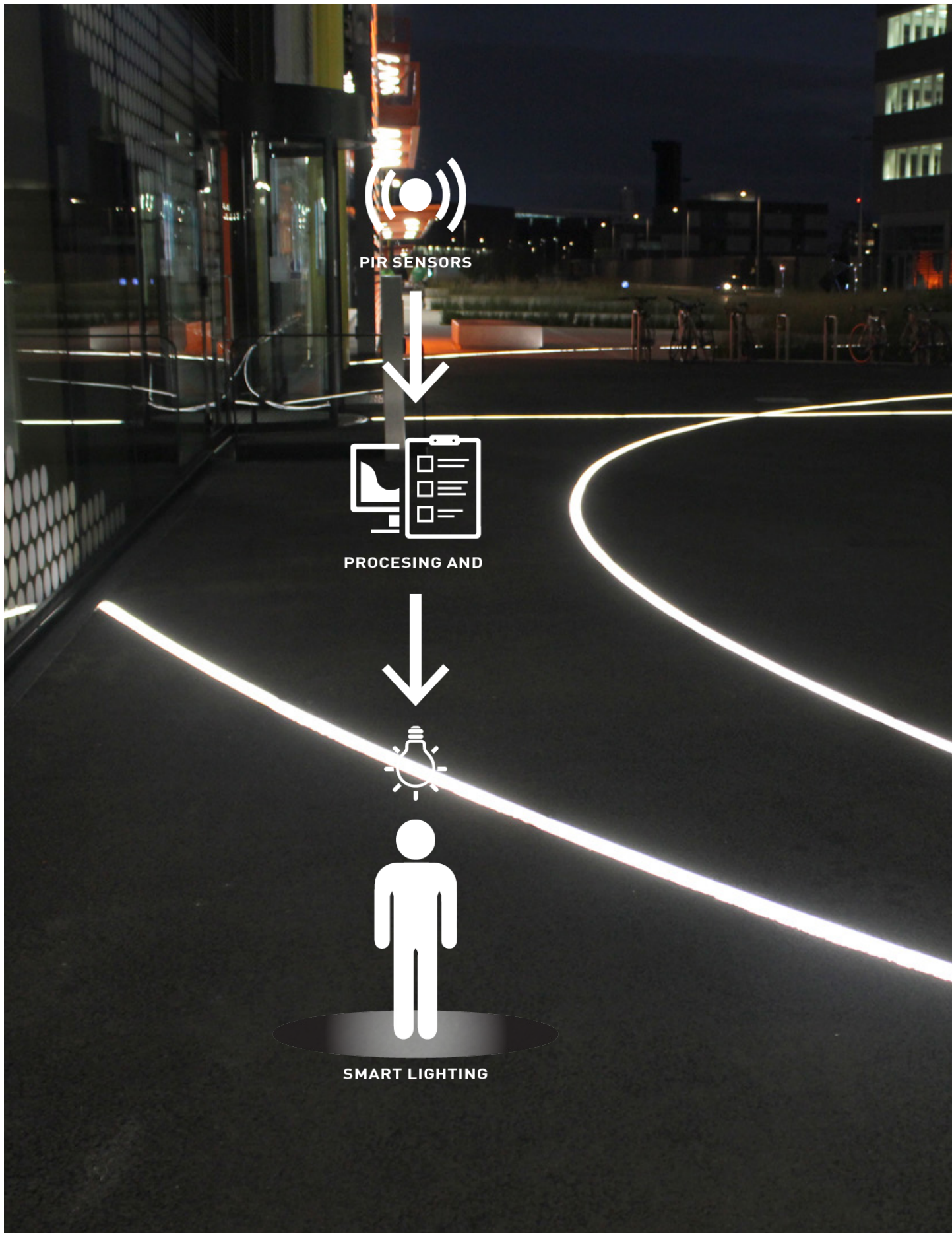
The artist mainly uses inexpensive and easy-to-reach fluorescent cables, perfect lines with a special technique that includes stretching, knotting and glue. “In general, I start with a model and the initial structure, but many ideas also arise in the implementation” (Choi, 2013). It also includes a pure white thread that lights up in violet blue when the black light is turned on, but becomes almost invisible when it is turned off. The effect is an intelligent mixture of the analog and the ephemeral, where the emptiness of an empty room becomes tangible (Kushins, 2013).

“Visitors are initially confused; at the first look, they lose orientation,” Choi says. Given time, however, after exploring the area and experiencing a range of different perspectives, that discombobulation transforms into something else entirely. “Oftentimes they’re put in a meditative state and feel very relaxed and at peace.” (Choi, 2013)

Figure 22. Photography of UV-Light by Clossal, 2013

Figure 23. Photography of UV-Light by Clossal, 2013

4. THE PROPOSAL



4.1. Process of Design

Given the context of 5G technology and the growing development of new technologies it is appropriate to consider the concept of intelligent lighting as part of the Smart City concept. Currently a wide range of functions are offered, which are beneficial for the urban lighting of our cities where people will be connected with multiple services in a more efficient way.

The proposal starts with Smart City's tendency to develop an intelligent lighting system, this technological system is based on a set of sensors, controllers and, of course, a network of lighting strategically distributed in the urban structure. The objective is to encourage an increasingly efficient use of resources by reducing the final cost of the system by maintaining or improving the level of lighting in the cities. This last aspect is very important and is the point on which revolve all the efforts and innovations of recent years, since lighting is very important for our lives, which directly influences aspects as important to us as emotional health and security.

The proposed lighting system will be interactive and will be based on the principle of offering more with less, that is, maintaining or improving the level of luminosity with a lower energy cost, in addition to offering the user an interactive experience. Each of the steps that this technology has taken has always been low cost, which has meant energy savings that have taken the step of implementing an intelligent lighting model in several spaces.

Thanks to the various advances available in the market, the sensors are able to capture the ambient light and turn on or off at the necessary time, always according to the parameters that the user indicates, and that is where the revolution of urban lighting lies. Also, the user may be able to adjust the lighting, turn off, regulate the intensity, change the tone, adjust the height and the projection area, including regulating the intensity of the light depending on the state of your mood.

For Barcelona it would be the perfect opportunity to face the urgent need to create new urban innovation strategies that promote the development of the new economy and that entail great social benefits at the same time. To make this possible, various types of sen-

sors will be installed, such as light, movement, sound, speed and thermal sensors. Thanks to interactive systems can be configured and its operation allowing the lights to turn on or off according to the time of day, if they detect someone moving or the thermal aura of a person in dark environments.

Figure 24. Photography of Here East Stratford by The Light Lab, undated; Diagram Process of design by Ursula Eyzaguirre, 2019



4.2. User Experience

Artificial public lighting represents the social power of who decides and who uses it, citizens. Illuminated cities affect the behaviors, feelings, thoughts and attitudes of people, urban lighting must respond to the uses and needs of people in different contexts and times, reflecting the true meaning and purpose of public space.

Shaping illuminated space for people means exploring the true connection of people, light and the urban environment, using a social approach to lighting design. The light at night provides valuable benefits, since it is something that people seek and can represent an essential aid for road safety, personal safety against crime and nocturnal social activities, as it involves people and increases life in the cities in the dark. Light has a cognitive, aesthetic and symbolic role, it is useful to find ways and communicate information; it can help generate new ways of understanding and identifying places with an emotional effect (Ginthner, 2002).

The general increase in light is not the answer to create better places to live: bad lighting practices and the uniform use of the lamp have a negative impact on the visualization of the night sky by overexposure; in addition to obtaining lighting that saves energy.

People like lighting with variety and different shapes that permeate the walls, sidewalks and streets of buildings. The temporary, public or private, unreal, unexpected and unconventional lighting effects enrich the experience of the lively, colorful and surprising city at night. This type of light did not really mean a functional lighting role but it really enriches the texture of the night.

This research is about the opportunity to explore the nightlife to a large extent. The proposed system allows people to assume a more active role in the configuration and experience with lighting, and for this it is vital that through the sensors the needs are detected.

Within the context of Smart Cities, some North American universities are already testing the first intelligent models, counting with dozens of volunteers who experience a fully automated lighting system. Every day new needs are detected caused by

the diverse and multiple interactions, in most cases simultaneously, of the volunteers. It is clear that in the same way that the UX (User eXperience) is imposed in areas such as web usability or the development of new mobile interfaces, the experience will end up shaping the way we communicate with the new Smart Lighting systems of our cities.

The project focused more on the qualitative aspects of the perception of the city at night, the design parameters and the indexes describe the quantity of the lighting environment. This research explores what lighting functions in real use people prefer instead. Achievements can be transferred to lighting design standards to support the design process for the creation of better-lit cities.

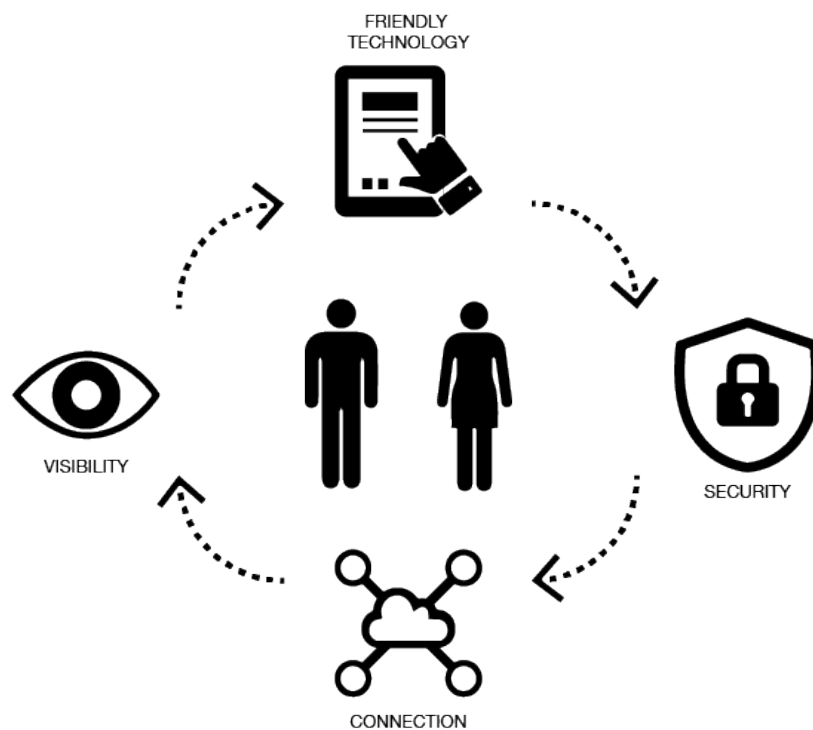
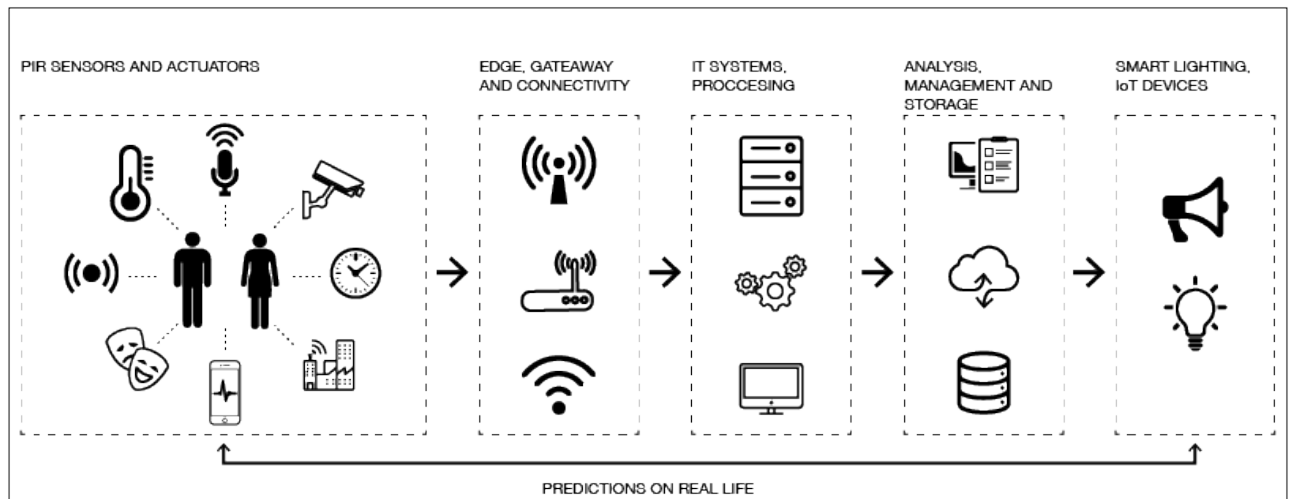
The designed and unconventional lighting elements have a broader growth potential to change the human experience of the urban night landscape. Variety, colors and contrasts are the most important characteristics of an illuminated urban environment. The proposal focuses on the creation of well-lit places where users can interact between light and space, light and shape, light and surface, light and texture, light and weather conditions and, most importantly, light and human activity.

Light provides the mystery of discovery and makes people feel good, as proposed by Kaplan and Kaplan, the perception of enlightenment involves 4 main concepts of coherence, complexity, readability and mystery, related to the constant need of the human being to extract information about their environment (Kaplan and Kaplan, 1989). The night-time environment has to provide exploration, stimulate the senses, while providing enough information to allow evaluation and guarantee a sense of security.

Figure 25. Photography of Barcelona busy street girl smiling by Adrian Dorobantu, undated.

Figure 26. Photography of Arc de triomf barcelona by Adrian Dorobantu, undated.

5G TECHNOLOGY



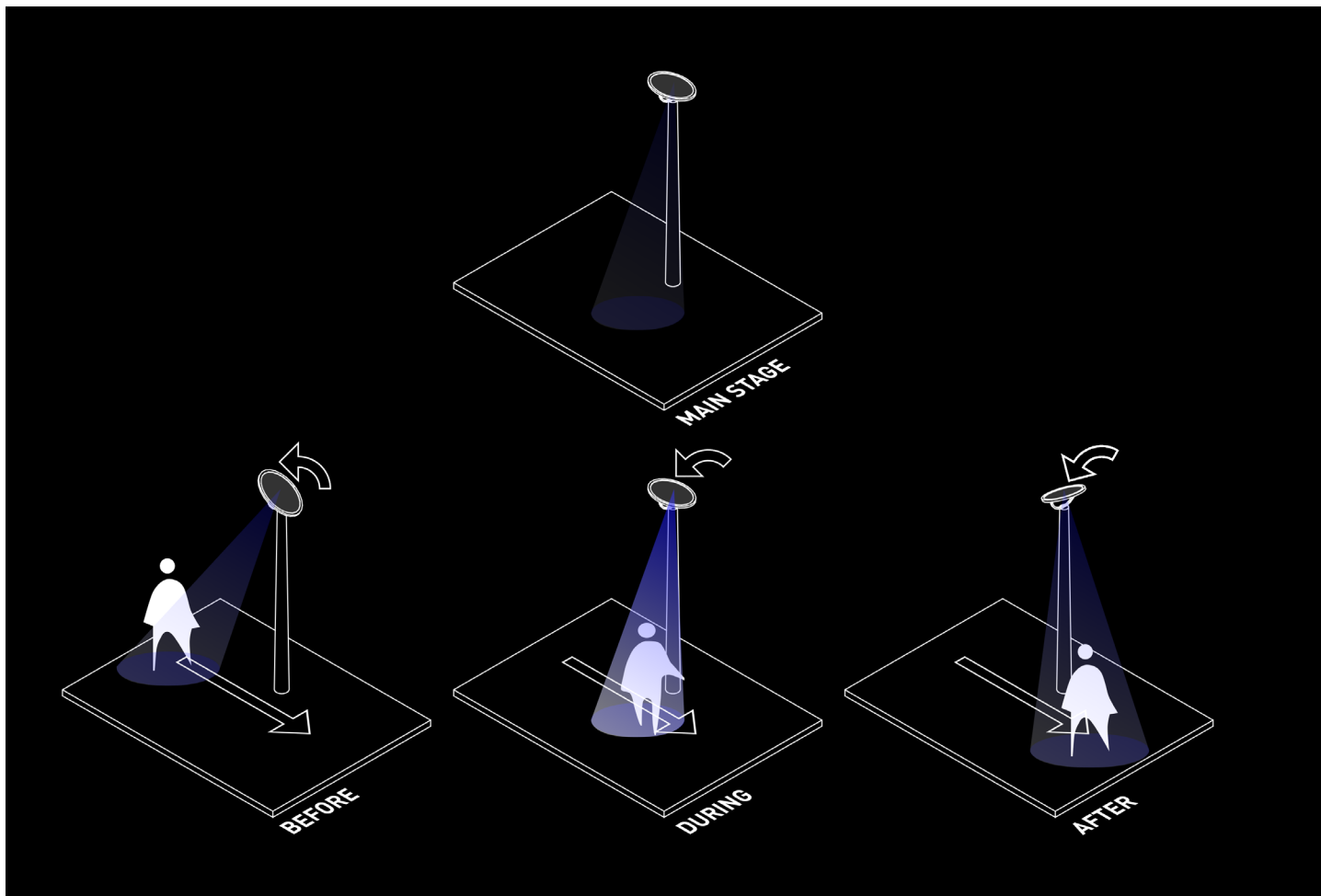
The night image with a non-uniform lighting distribution, made with interactive technologies where darkness and light are in a balance, lighting design should focus on quality instead of quantity and should not be defined in a rigid order, but which should provide a framework of different lighting variables to formulate a global and comprehensive visual and visual lighting design plan. Emotional characteristics of the nocturnal urban landscape.

The lighting must be dynamic and offer possibilities of emotion, as well as points of emphasis and interest within the place, while satisfying the sense of security. The enrichment of the public domain at night is not achieved flooding everything with light. The landscapes of the night city are more appreciated when they combine different lighting effects, such as the general ambient light, the focal brightness and the bright play that define a good lighting effect only if they are used together.

The backlight is necessary to reveal the nocturnal form of the city, creating a comfortable and relaxing place that does not reproduce the effects of daylight but defines a new image of the city at night. The focal brightness is important to attract attention, attract interest and point out the important element of nocturnal urban landscapes. Also, a set of lighting elements that are important to create a magical atmosphere, excite people and enchant their senses, are the light games defined by lines, points, flashes, brightness, brightness of light create an atmosphere of enchantment, increasing all sensations (Peters, 1992).

Figure 27. Diagram of 5G Technology by Ursula Eyzaguirre, 2019.

Figure 28. Diagram of Smart Lighting by Ursula Eyzaguirre, 2019.



Timing	Before	Light appears ahead of the user.
	During	Light appears on top of the user (as a spotlight).
	After	Light appears behind the user.
Transition	Soft	Light appears gradually (slowly).
Controls	Hard	Light appears abruptly (rapidly).
	Random	Light appears at random times.
	Always-On	Lights are always on.
	None	Lights are always off.

4.3. Strategies

In a city it is essential to have an active urban environment to promote social behavior in public spaces. Lighting allows creating scenarios where interactive situations are generated that help to better understand the influence on people's interactions and social perceptions. Research shows that enlightenment can trigger positive behaviors, since there is a direct link between light, affection and mood.

The main strategy of the proposal is based on LED technology because they offer the possibility of highly sensitive interactions with low energy costs. The daily and interactive lighting is managed in two different planes: the user interface and the context, including in the latter the user's motivations, lighting needs (functional and emotional). The interface is defined as the tool by which the user gets involved with the system, for which he can customize color, intensity, synchronization, angle; despite their autonomous behavior and interaction qualities.

The proposed system combines the parameters of interaction and information to create a sidewalk experience that covers the surface and is sensitive. The hypothesis is that the expectations and needs should be equivalent to those of the proposed lighting for the urban space. Implicit interaction and accessibility The theory of implicit interaction [10] describes the qualities of intuitive communication between users and devices.

First, the interactions must be dynamic, that is, adapt the appearance, behaviors and responses to changing situations. Second, they are demonstrative: they use actions and incarnations for expressiveness. These qualities determined the design of the interactive system. Both concepts were applied in the proposal. The lights adapt to the speed of pedestrians while displaying welcoming and pleasant lighting patterns.

The participants are introduced to the different light conditions, these conditions were created from the combination of two factors: synchronization and transition. Time is defined as the moment the light appears (lights up) in response to the user's speed. The types of time are: Before, During or After, depending on whether the light appears in front of or behind the user. A control condition for the interaction value has

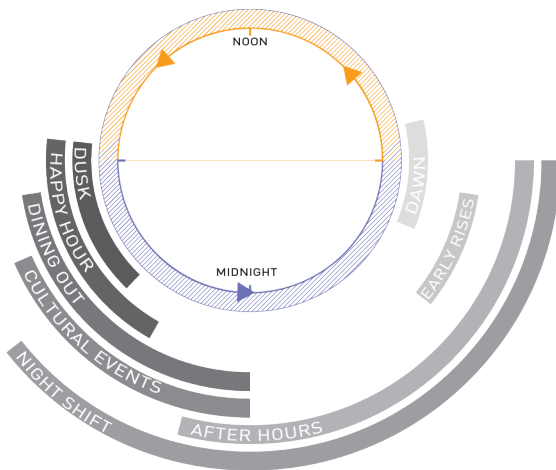
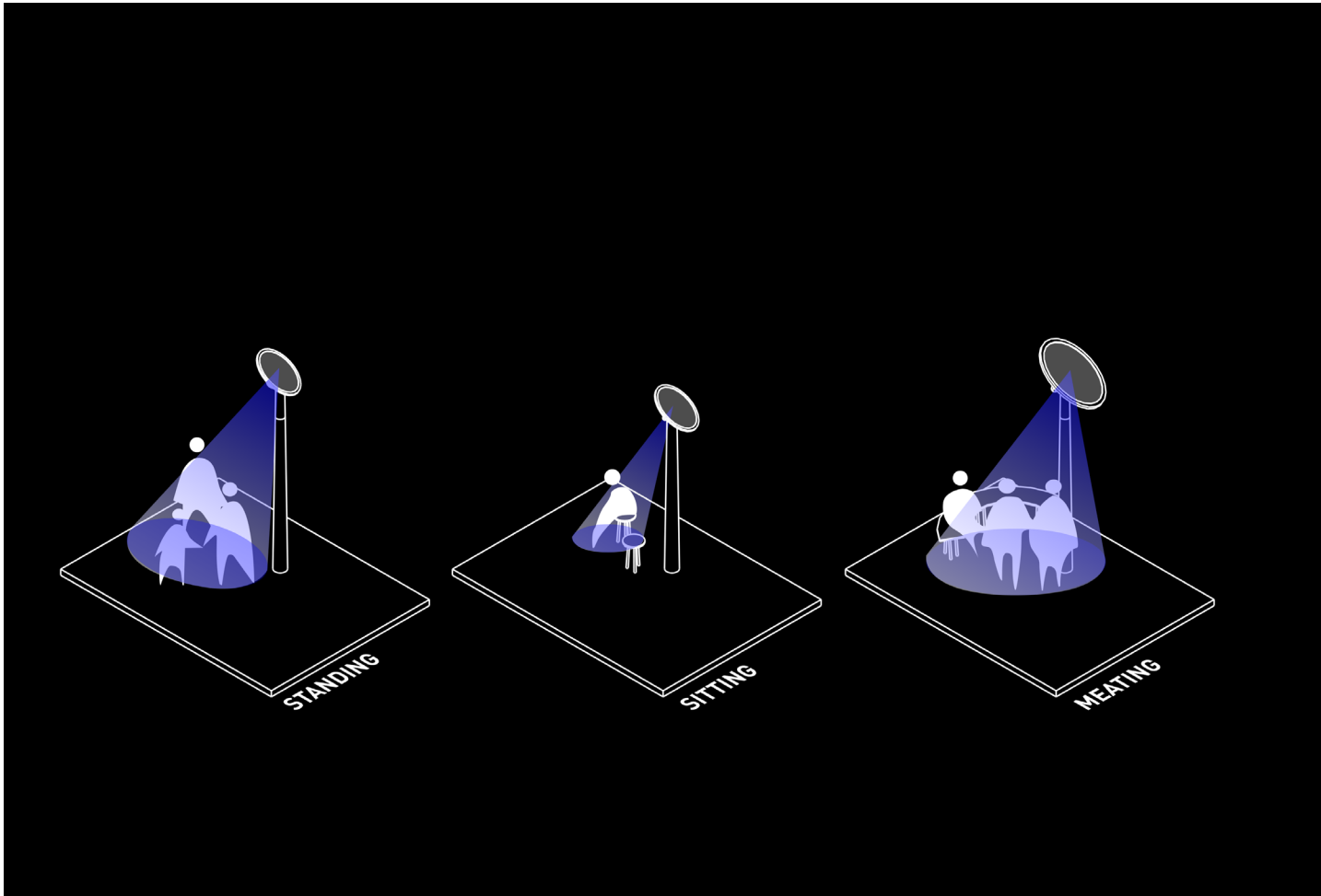
lights that appear at random intervals. The transition is defined as the way each light is turned on. It is a smooth and gradual transition.

These factors combined to create the different conditions; for example, when the lights appeared slowly before the users, they experienced the condition of softness. If the lights appeared instantly and behind the users, this would be the condition After the difficulty. The circles of light appear projected on the floor while the participant walked down the corridor. In addition, a condition Always activated, of very low intensity is added to create a slightly illuminated environment that invites to be in it.

Time has a direct impact on the experience of interactive urban lights. The research relates the positive emotional effect to the way lights appear while pedestrians walk. The lights that appear in front of the pedestrian should usually be chosen to obtain positive emotional results. However, lights that are always on (environmental) could be more useful in situations where safety and attention to obstacles are expected. The lights that appear instantly give users a greater perception of brightness, while the lights that appear gradually are more relaxing. In addition, smooth transitions are better accepted by users. This implies that the variant designs can benefit from smooth transitions, while the utility designs could benefit from outstanding and punctual light transitions.

Figure 29. Diagram of Strategies by Ursula Eyzaguirre, 2019.

Figure 30. Diagram of Timming Strategies by Ursula Eyzaguirre, 2019.



The proposal marks coherence with the place or situation with a lighting scheme. For example, people who are in unusual places expect a lot of light to reduce anxiety. On the other hand, people in less stressful places would be more open to pleasant surprises of enlightenment. In summary, the design options for interactivity must match the perceived level of security. External factors, such as time of day, ease of walking in the neighborhood, as well as internal factors, such as personality, past trauma, femininity or perceived masculinity and stress levels modify the perceived safety and, therefore, the perceived emotion towards a place (Haans, and de Kort, 2012). Consistent designs take into account the context and personal characteristics to choose the best lighting modes.

One of the advantages of this new system (LED) is that you can reduce energy consumption by taking advantage of the energy efficiency of interactivity. Interactivity allows reducing light pollution and energy consumption, which is why it is proposed as a new way of lighting and interacting in the city, which can be applied incrementally.

Figure 31. Diagram of Strategies with Variations by Ursula Eyzaguirre, 2019.

Figure 32. Diagram of Shades of Night by Ursula Eyzaguirre, 2019.



4.4. Features

LED street lights provide a light of high energy efficiency and quality, but they are also sensor nodes on an information highway. In the near future connected lanterns could transmit data among millions of devices given the connectivity through fifth generation technology. The connected lighting infrastructure collects and distributes data and improves the city's services such as light, traffic, air quality, public safety, parking and other location-based services, taking advantage of the most advanced communication technologies. Citizens will be able to transit the city safely, use and communicate with sensors in street lights that explore the road and pavements, and provide a frame of reference when transmitting situational information (Lin, 2016).

LEDs (light-emitting diodes) are the latest and most exciting technological breakthrough in the lighting industry. LEDs are small, solid bulbs that are extremely energy efficient and durable. LEDs work differently than traditional incandescent bulbs. This makes LEDs much stronger and more durable than traditional incandescent bulbs.

Among the advantages of LED lights, we can rescue the following:

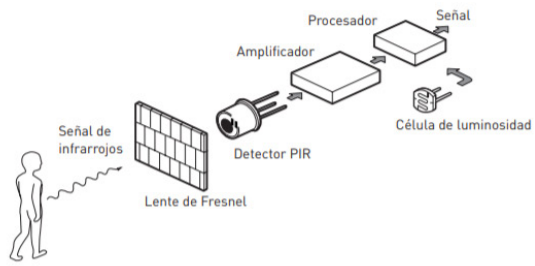
- LEDs are now capable of emitting 135 lumens / watt Long service life: 50,000 hours or more if designed properly.
- LEDs are also called "solid state lighting (SSL), because they are made of solid material without filaments or tubes or bulbs to break.
- No warm-up period.
- It is not affected by low temperatures.
- With the LEDs, you can direct the light to where you want it, so that no light is wasted.
- Excellent color reproduction, do not eliminate colors like other light sources such as fluorescents.
- Respectful with the environment, they do not contain mercury or other dangerous substances.

- Controllable, LEDs can be controlled by brightness and color.

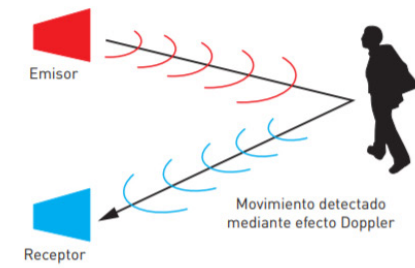
LED technology is used to adapt the interactive design with a low energy cost system. The proposal shows potential design options for different combinations between the type of available energy and the type of urban space. Depending on the type of urban space, you must apply different types of design options, such as design for comfort, efficiency and safety. LED technology helps create comfort and efficiency contexts that focus on the best affective result that interactive lights take advantage of.

Smart LED technologies, combined with a growing understanding of the impacts and qualities of different types of light, equip us with the tools to face complex urban challenges in new ways. Night lighting can be more sensitive to environmental, social and contextual needs through intelligent technologies. Sensors and the Internet of things pave the way for intelligent solutions that can respond directly to local activities and conditions.

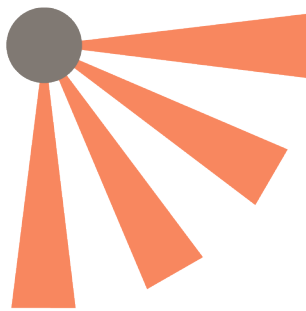
Figure 33. Photography of Kings Cross Tunnel by The Light Lab and Speirs+Major, 2015.



Infrared Detection



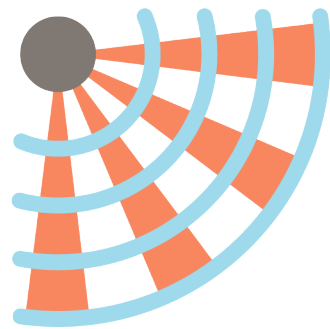
Ultrasonic Detection



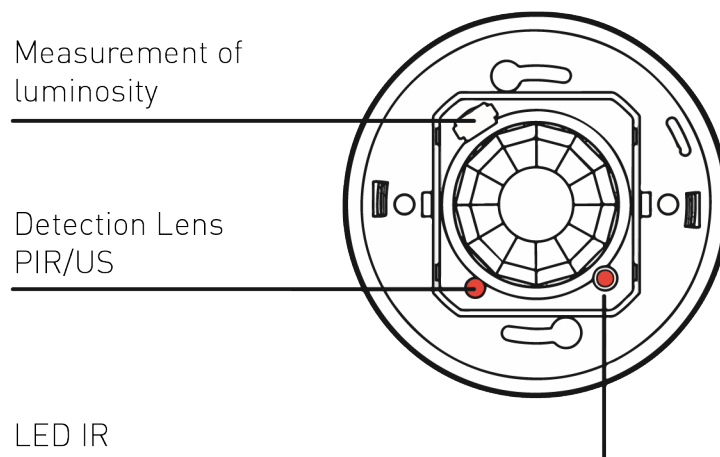
PIR SENSOR



US SENSOR



PIR/US SENSOR



A passive infrared sensor (or PIR sensor) is an electronic sensor that measures the infrared (IR) light radiated from objects in your field of vision. They are mainly used in motion detectors based on PIR. All objects with a temperature above absolute zero emit heat. In general, this radiation is invisible to the human eye, since it radiates in infrared wavelengths, but it can be detected by electronic devices designed for that purpose. The PIR perceives a change in the environmental energy of the area they are protecting by being quite sensitive to the energy produced by an intruder in motion.

The type of energy referred to is known as infrared energy and is contained in everything on earth. The most common source of this is the sun, but objects do not need to be warm or hot or bright to have it. The temperature of an object is not the only thing that contributes to its total content of IR energy. Color, temperature and texture are additional factors that determine your total energy level. The term “passive” refers to the fact that PIR devices do not generate or radiate any energy for detection purposes. They work in their entirety to detect the energy emitted by other objects. PIR sensors detect infrared radiation emitted by an object, which is often associated with the temperature of the object. One of its main applications is in security alarms. These can be connected to the system central via cable or wireless.

Its main component are the pyroelectric sensors. It is an electronic component designed to detect changes in the infrared radiation received. Generally, within its encapsulation they incorporate a field effect transistor that amplifies the electrical signal that it generates when said variation of received radiation occurs. The infrared information reaches the pyroelectric sensor through a Fresnel lens that divides the protected area into sectors. Lenses with different characteristics are distributed: wide angle, curtain, corridor, etc.

When the infrared sensors (PIR) are installed, if an intruder enters the room, a change in the infrared radiation of the environment will be experienced and the PIR will give an alarm condition. Once the calibration and adjustment of the detector has been carried out, the test led should be turned off by installation norm. In order to achieve total reliability, this

technology also integrates a special light filter that eliminates any possibility of false detections caused by visible light (solar rays), as well as special circuits that give greater immunity to radio frequency waves, as well as it's how motion sensors work.

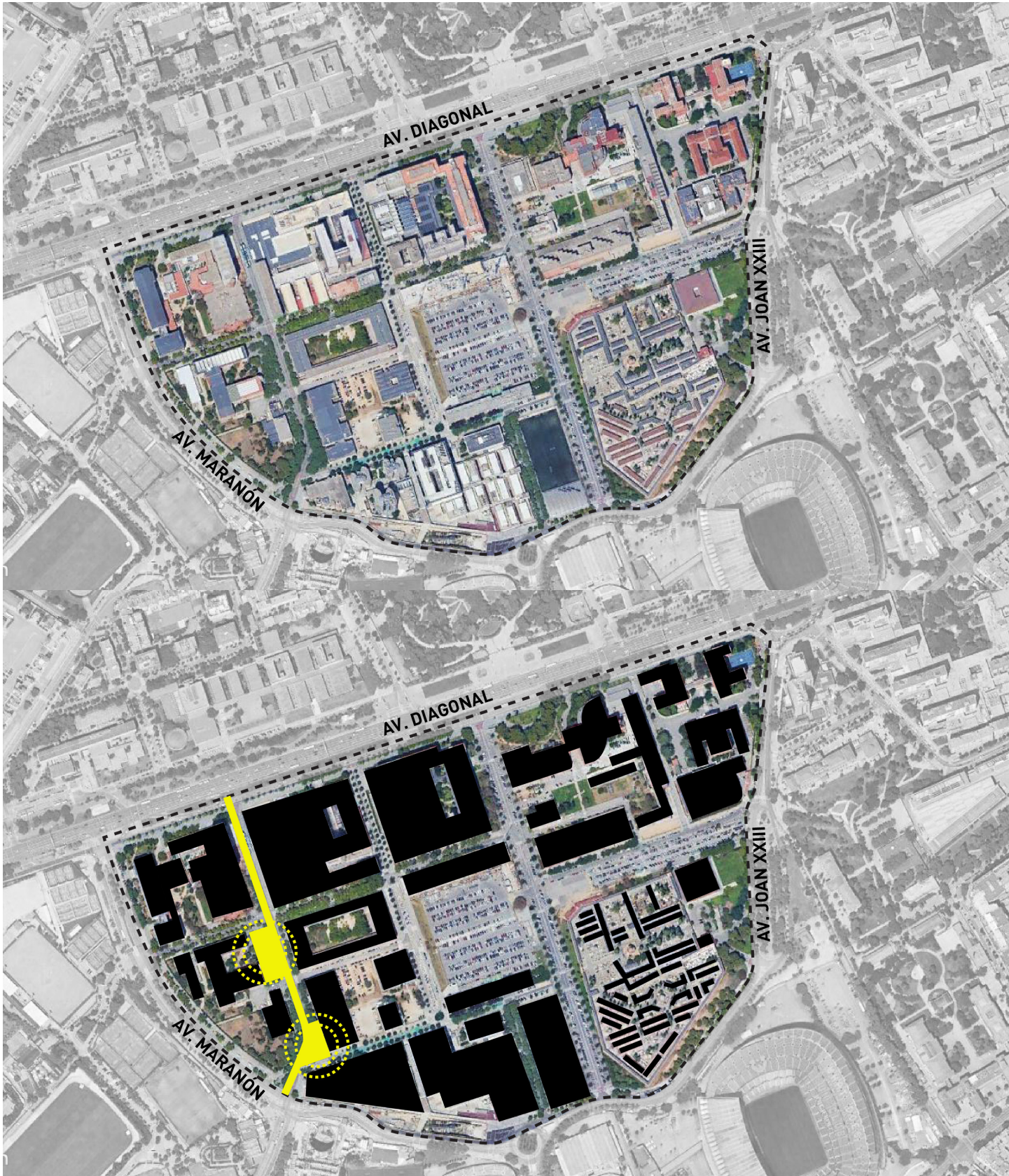
Because the PIR has become so popular, manufacturers have invested their resources to make technology as reliable as possible. One of the most popular developments in this area is the Pulse Count system. This system allows the PIR to distinguish between false alarms and the presence of the individual, and reject all activations except those caused by an intruder. As soon as a negative or positive pulse is generated, a special counter and timer in the PIR maintain a record of activity in the area.

On the other hand, ultrasonic sensors (US) emit imperceptible sound waves for the human ear by means of an oscillating quartz at a frequency of 40 kHz and a power <110 dB at 1.5 m. These waves are emitted in the radius of coverage of the sensor and bounce off objects, surfaces and people. When the waves return to the sensor, their frequency is measured. The movement is detected by a slight lag of the frequency (Doppler effect), which activates a presence signal. The ultrasonic sensor can “see” around objects and surfaces, as long as the surfaces of a closed space are hard enough to allow the bouncing of the sound waves. No radio wave emissions, Ultrasonics equal to mechanical vibration.

The sensors with double technology use the two technologies, PIR and Ultrasounds, which allows a maximum reliability and coverage with a minimum of false detections. When a presence is detected, the light does not turn on. In case there is not enough brightness, the sensor makes the adjustment to turn on the light only if necessary. The lighting can be managed at any time manually (the regulation is cut off). After the person leaves the space, after the timing, the light goes out.

Figure 34. Definitions Of Detection Technologies by Ursula Eyzaguirre, 2019.

Figure 35. Design of PIR/US Sensor by Ursula Eyzaguirre, 2019.



4.5. Location

The University Area is a part of the district of Les Corts on both sides of the Diagonal, is the main cluster of university teaching. Full of students, it hides two of the most beautiful and quiet areas of the city: The Pedralbes gardens and the Cervantes park. It is the area of Barcelona where most of the faculties of the University of Barcelona and the Polytechnic University are located, which generates a characteristic movement on Diagonal Avenue.

Within the southern area of the university area there are two places in which I will focus to develop the proposal. These spaces are some elements such as light poles, benches, trees, etc.

The university area has practically no use at night, dark and inaccessible for decades. The proposal takes advantage of the potential offered by the site and also helps to revitalize the context for citizens. Since the university zone does not serve its purposes, it offers a great opportunity to try new forms of interactive lighting that encourages nocturnal activity, creating an illuminated and safe place to walk and where you can be. The development of urban lighting in this area promotes provisional nocturnal uses that seeks to create a “chain reaction” that alters the current destination by diversifying the social potential of the site.

By inserting minimal interactive lighting fixtures, flexible, reusable and sustainable, the site is conceived as a temporary destination in the city within which uses will grow exponentially as the attributes of the site are discovered. Reconnecting the university zone, the project aims to become a catalyst for the social appropriation of the urban coast; and to create an urban space where the inhabitants of the city exercise their right of citizens (Hernberg, 2012). Within the public space of urban dream is created by the public itself. Individuals paint the city with movement and light.

Figure 36. Map Delimitation of University Area by Ursula Eyzaguirre, 2019.

Figure 37. Map Public Spots of the Proposal by Ursula Eyzaguirre, 2019.



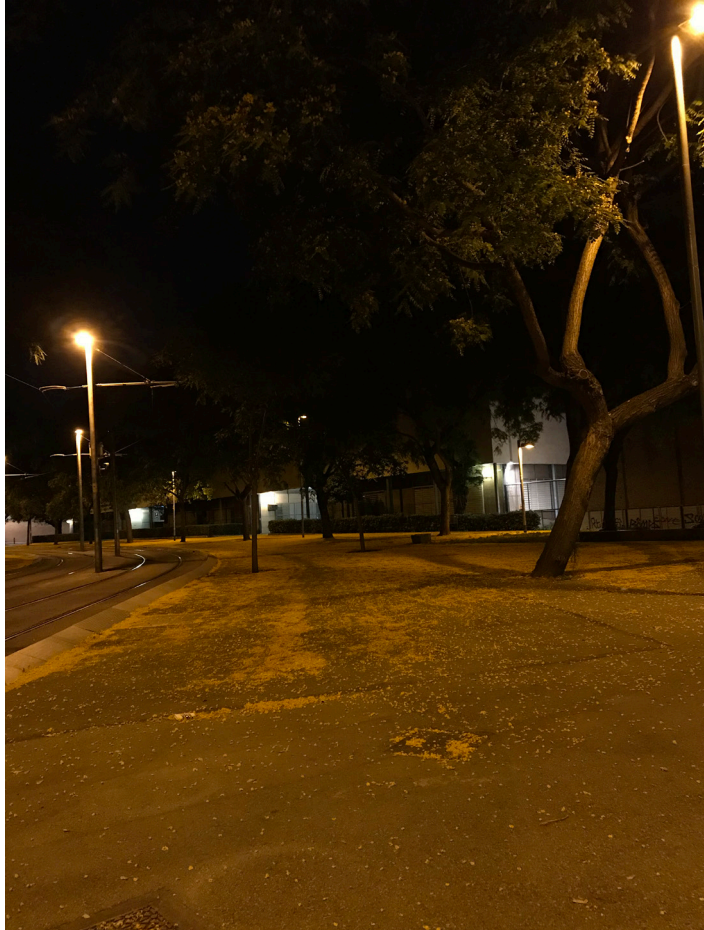


Figure 38. Photography of University Area, urban furniture by Ursula Eyzaguirre, 2019.

Figure 39. Photography of University Area, street lamp lighting by Ursula Eyzaguirre, 2019.

Figure 40. Photography of University Area, Tram way by Ursula Eyzaguirre, 2019.

Figure 41. Photography of University Area cross by Ursula Eyzaguirre, 2019.

Figure 42. Photography of University Area, square lighting by Ursula Eyzaguirre, 2019.

Figure 43. Photography of University Area, public lamp by Ursula Eyzaguirre, 2019.

Figure 44. Photography of University Area, square lighting by Ursula Eyzaguirre, 2019.



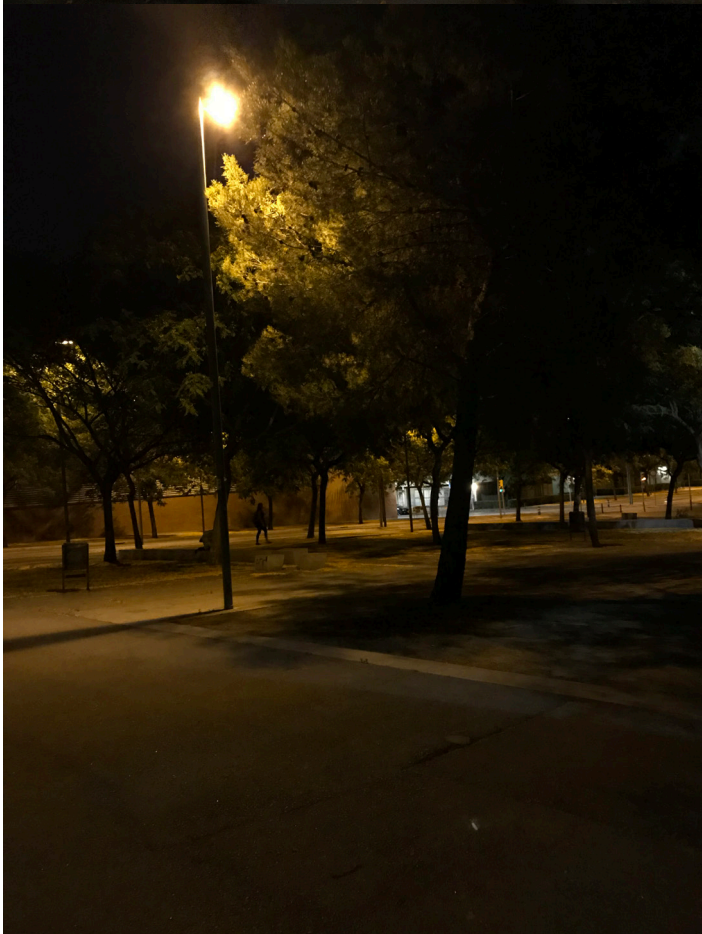


Figure 45. Photography of University Area by Ursula Eyzaguirre, 2019.

Figure 46. Photography of University Area, urban furniture by Ursula Eyzaguirre, 2019.

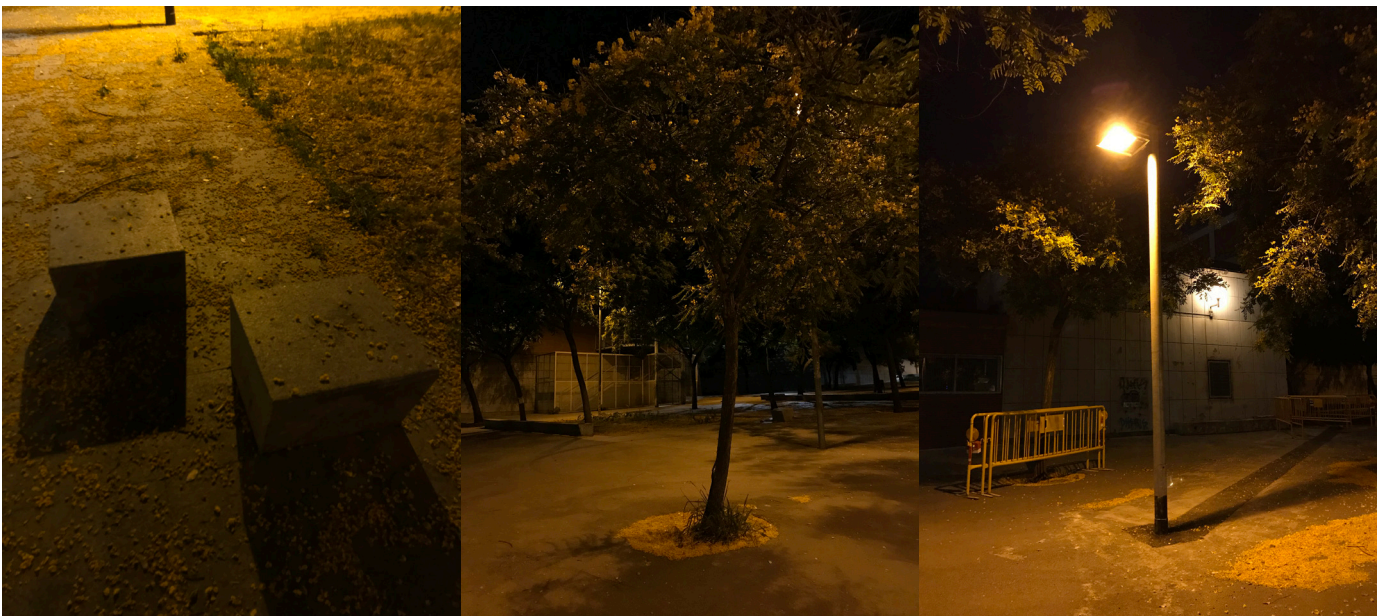
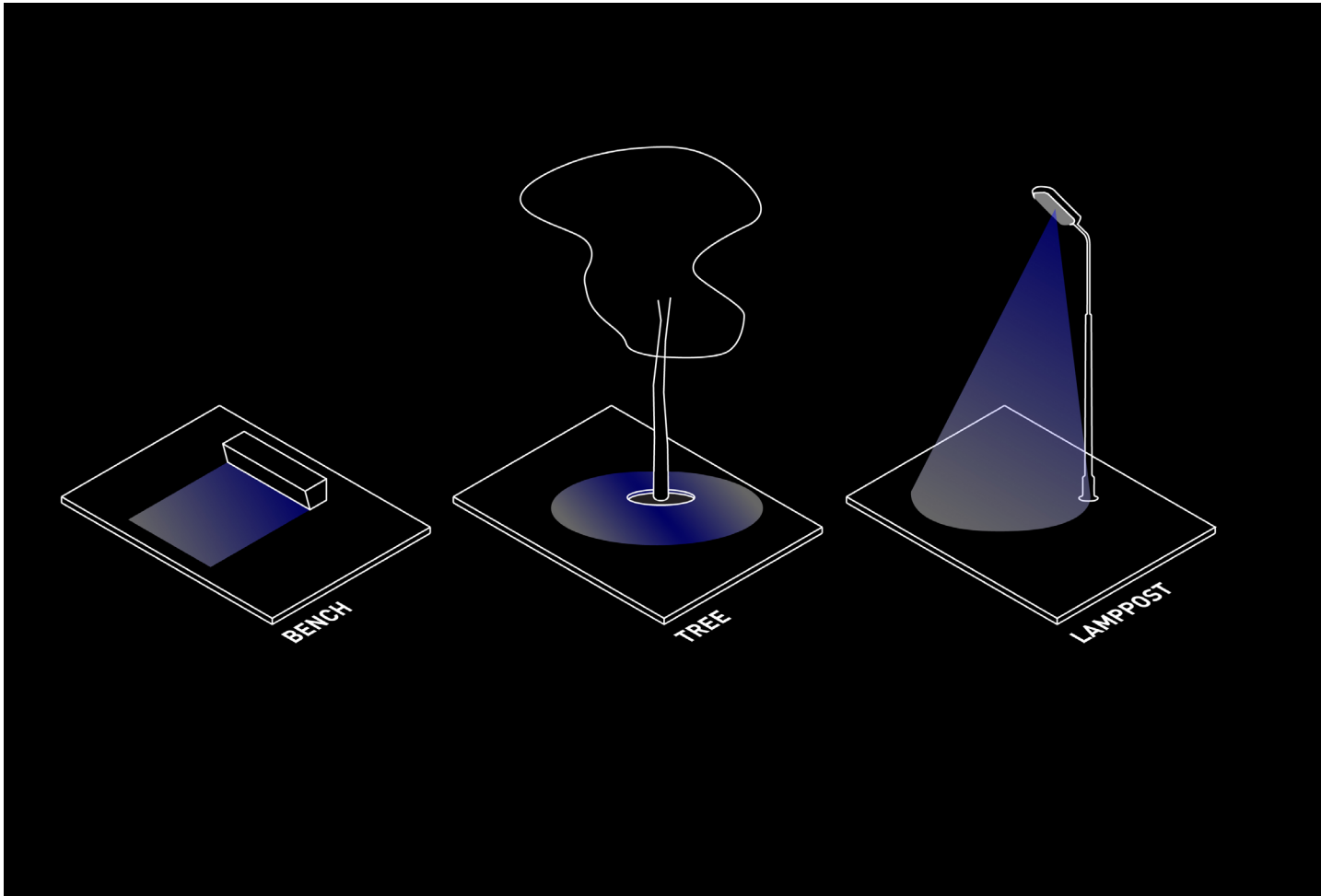
Figure 47. Photography of University Area, darkness by Ursula Eyzaguirre, 2019.

Figure 48. Photography of University Area, street lamp by Ursula Eyzaguirre, 2019.

Figure 50. Photography of University Area, square lighting by Ursula Eyzaguirre, 2019.

Figure 49. Photography of University Area, Tram by Ursula Eyzaguirre, 2019.

Figure 51. Photography of University Area, dark spot by Ursula Eyzaguirre, 2019.



4.6. The System

The proposed exploration focuses on two important points of the university zone, two squares that have urban furniture such as benches, lampposts, litter bins, etc. Light surfaces and points of light are created. The proposal establishes a series of external scenarios taking advantage of existing urban furniture. These atmospheres are created through the intelligent lighting system based on LED technology and sensors that detect the presence of people and activities and based on this is activated and allows temporary mixed uses. This simple strategy benefits from the existing qualities of urban space, which means that it is a low-cost system since it can be applied to the current context.

During the daylight hours of the day it is not necessary to have artificial lighting, while at night, when darkness arrives, the space will begin to light up in a linear way due to the original location of the streetlamps, this will create a slightly lit urban atmosphere that invites citizens to travel. This ambient lighting delimits a space to be outdoors, and leads to the development of other activities. A good ambient lighting will allow a better visualization of the city and increase the quality of life of people thanks to the livable that these urban spaces become and the feeling of security that they produce due to the integration of the dynamics of the city.

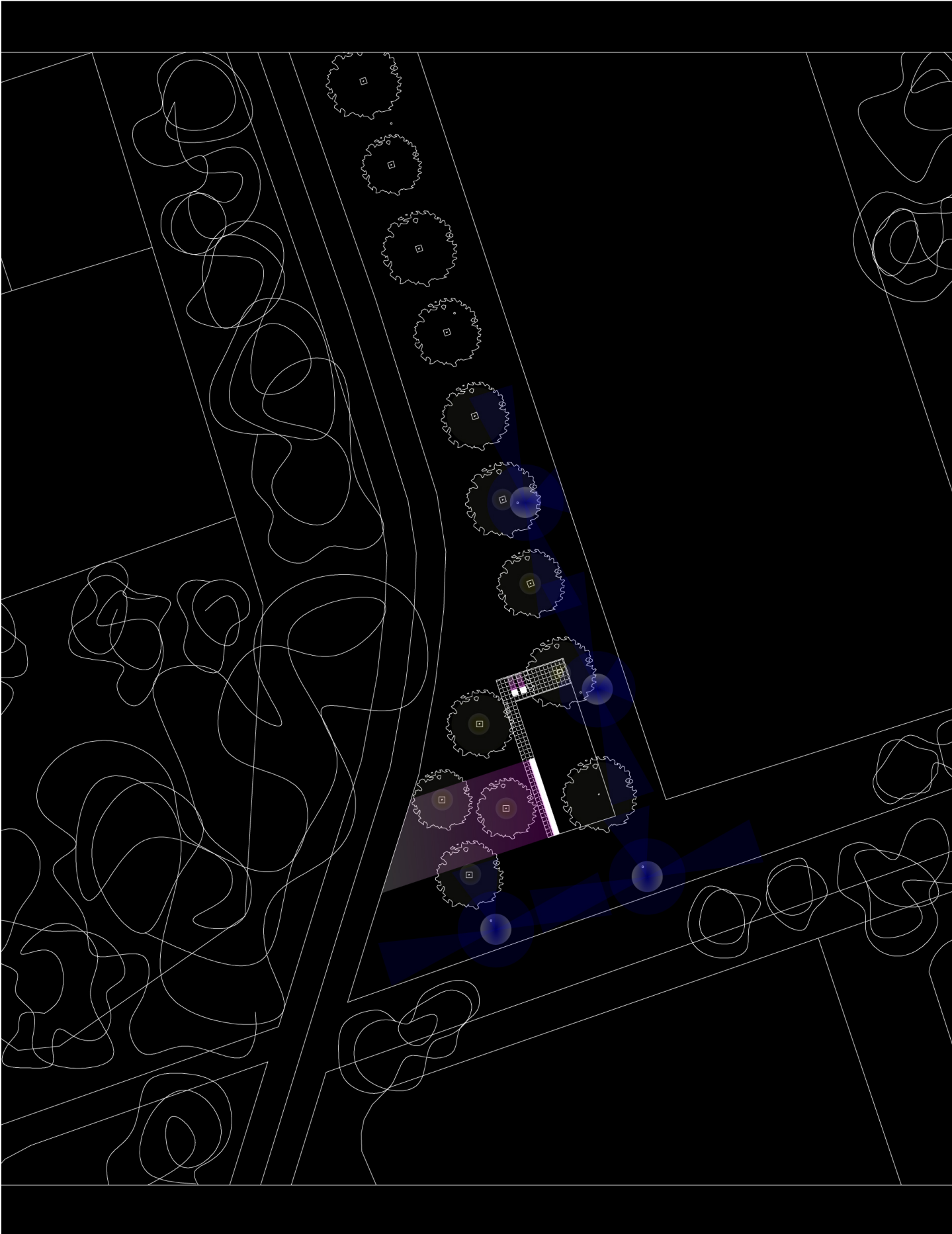
On the other hand, the system has lights applied to urban elements such as streetlights, benches; in this case the lighting will be directed according to the presence of people. From these elements, a light will be projected from the lower area, on the other side, in the case of streetlamps, it will be projected from the upper area. The area and intensity of illumination will depend on what is detected by the sensors. As the presence of people and the activities they carry out in space are detected, they will ignite. The proposed system combines the parameters of interaction and information to create a sidewalk experience that covers the surface and is sensitive.

Figure 52. Diagram of The Lighting System in University Area by Ursula Eyzaguirre, 2019.

Figure 53. Photography of Bench in University Area by Ursula Eyzaguirre, 2019.

Figure 54. Photography of Tree in University Area by Ursula Eyzaguirre, 2019.

Figure 55. Photography of Lamp in University Area by Ursula Eyzaguirre, 2019.



4.7. Zone 1

The lighting system is applied to these elements that are found in the spaces chosen within the university area. In the case of the benches and the trees, the light will be projected from the lower zone, on the other side, in the case of the poles, it will be projected from the upper zone.

The objective of these strategies is to allow a safer, more efficient and pleasant urban route, and it will improve dynamism in the urban space, intelligently using intelligent systems in combination with LED lights.

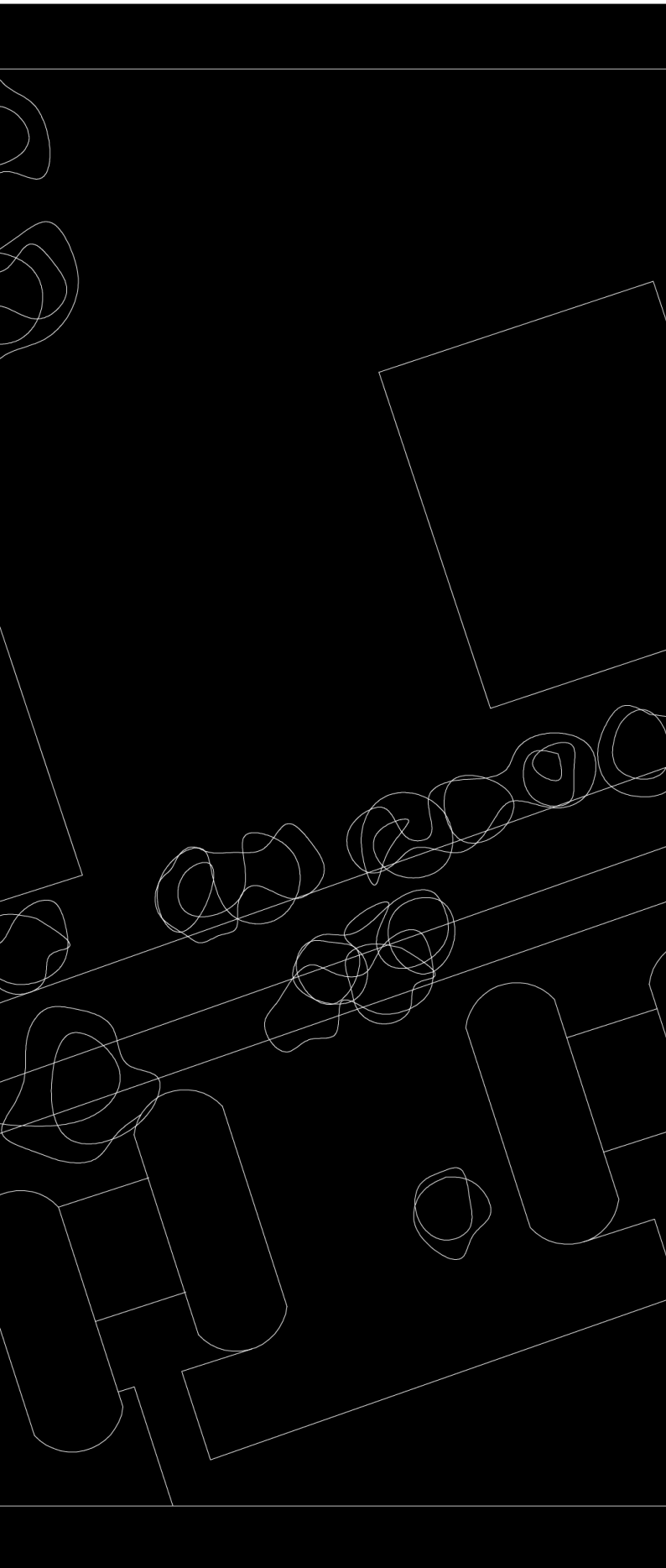
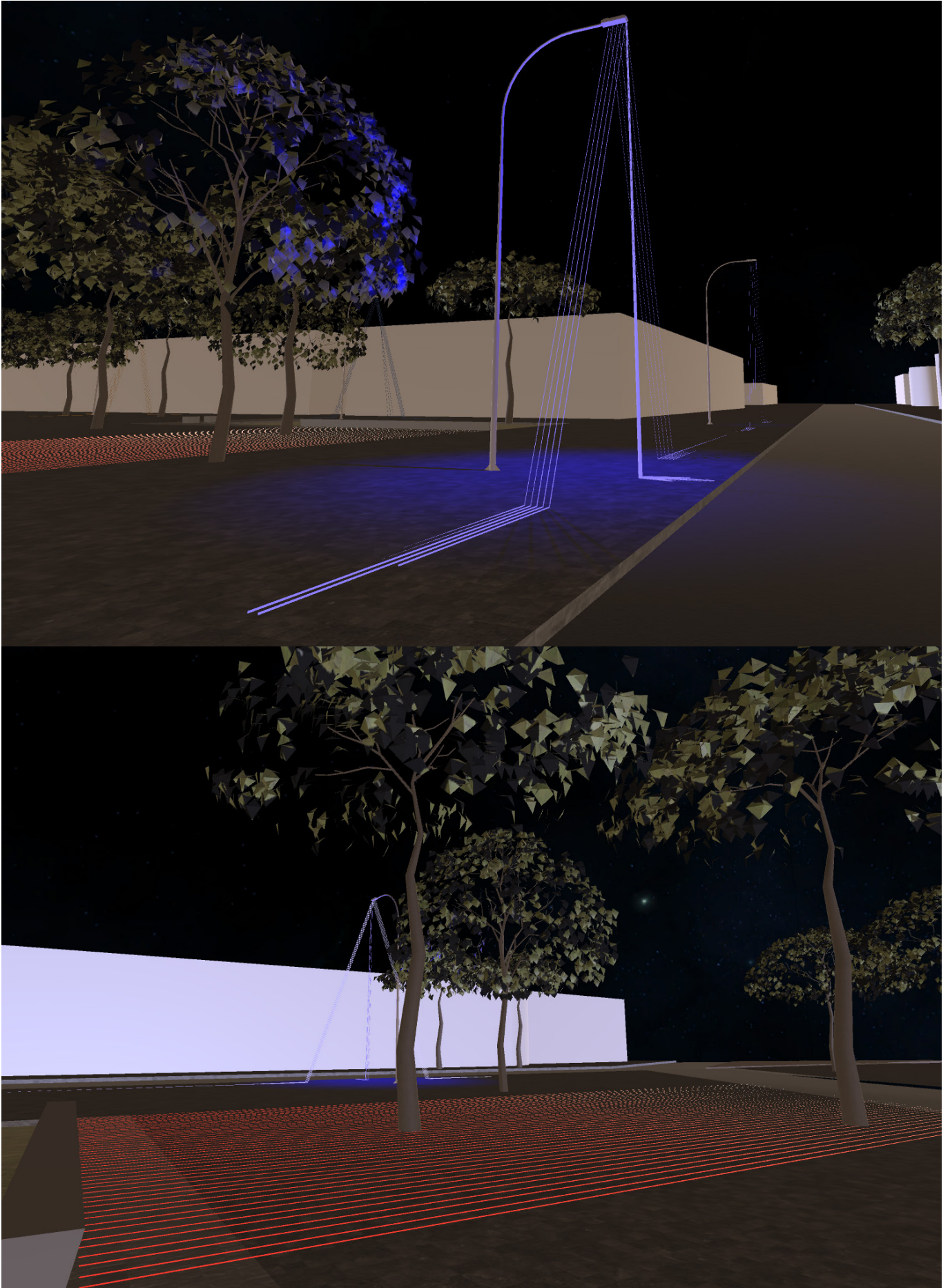


Figure 56. Plan of The Proposal for Zone 1 by Ursula Eyzaguirre, 2019.



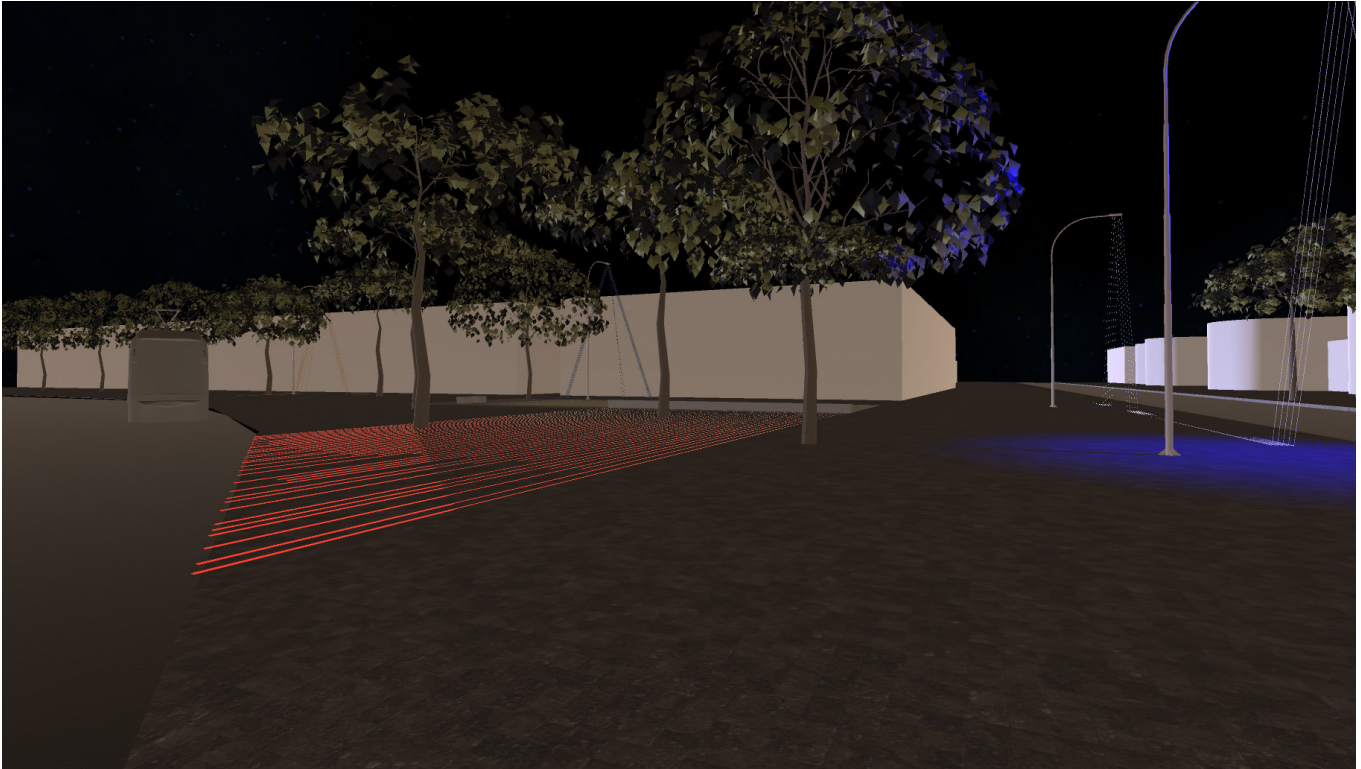
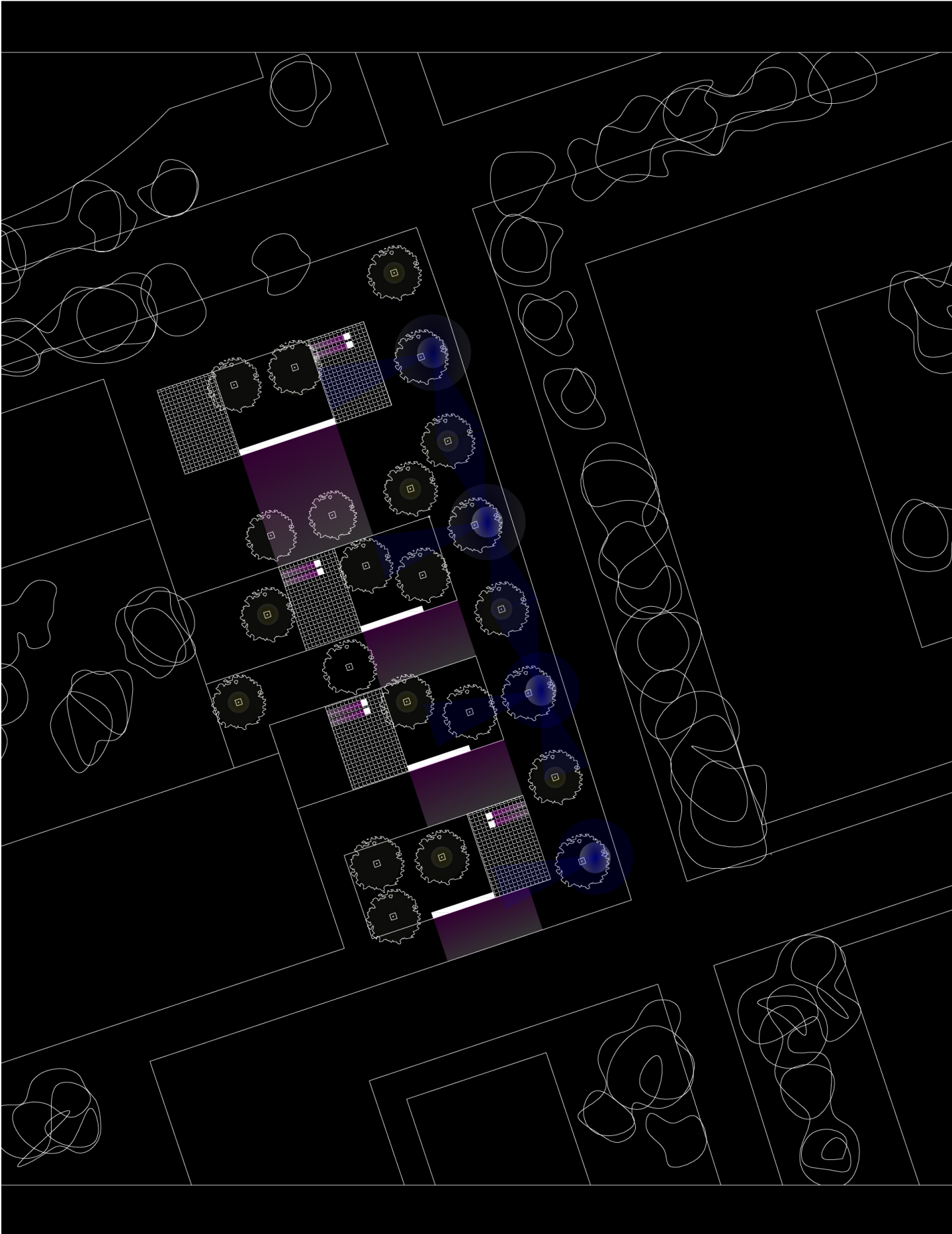


Figure 57. Rendering of Street Lighting Zone 1 by Ursula Eyzaguirre, 2019.

Figure 58. Rendering of Street Lighting Zone 1 by Ursula Eyzaguirre, 2019.

Figure 59. Rendering of Street Lighting Zone 1 by Ursula Eyzaguirre, 2019.

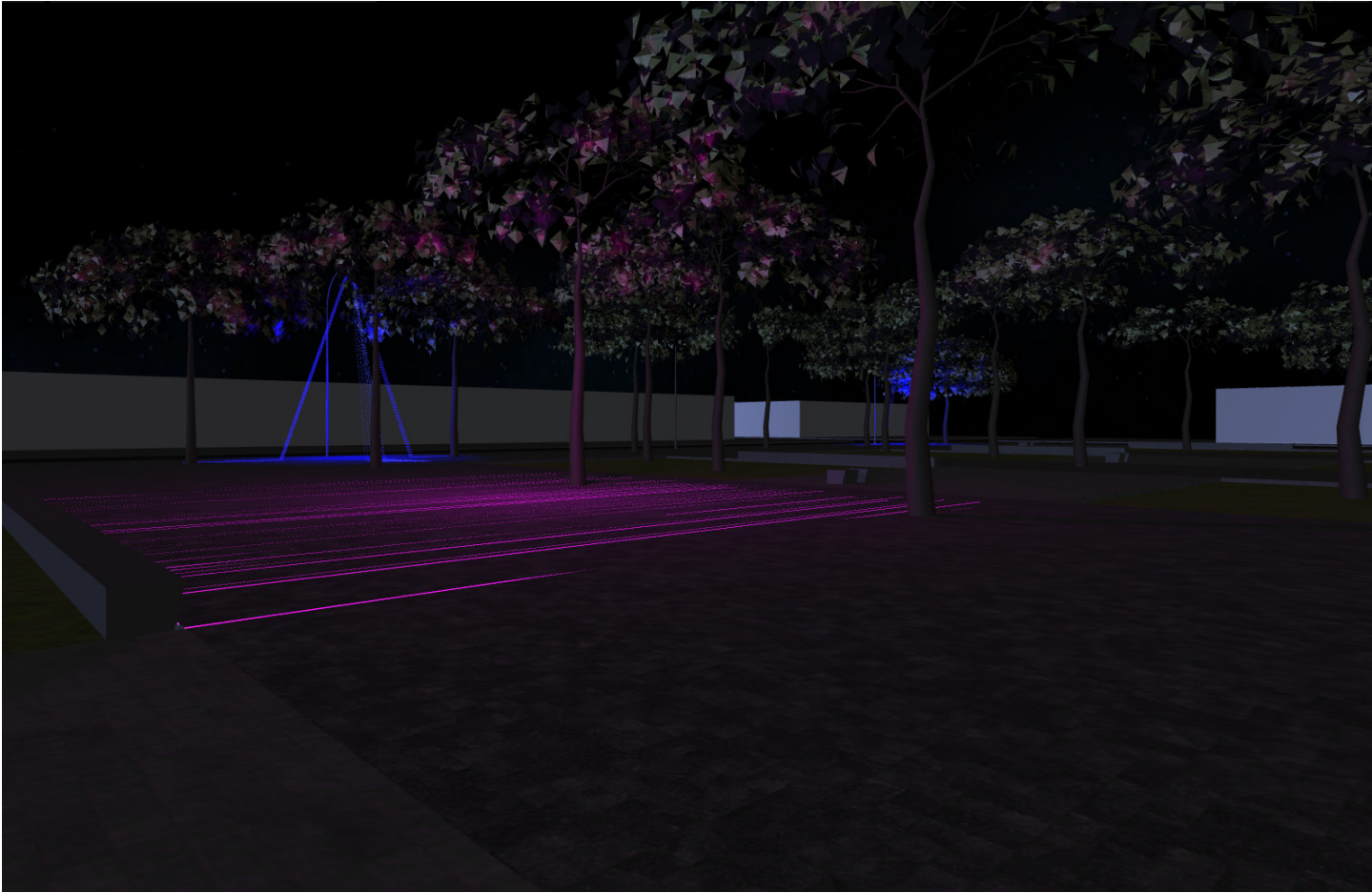


4.8. Zone 2

With this project I have shown significant relationships between interactive technologies with urban lights. The design conditions that engender positive responses from users. The highlight of the proposal is the energy consumption and light pollution reduction that could be achieved through interactive designs.

Finally, beyond the well known relationship between illumination and safety, the hierarchical relationship between emotions and interaction. I hope that interactive design parameters such as timing, transition, look-ahead horizon, and minimal lighting levels can serve as guidance to future designs for illumination systems that are not only efficient, but which improve the mood and affective state of urban residents.

Figure 60. Plan of The Proposal for Zone 2 by Ursula Eyzaguirre, 2019.



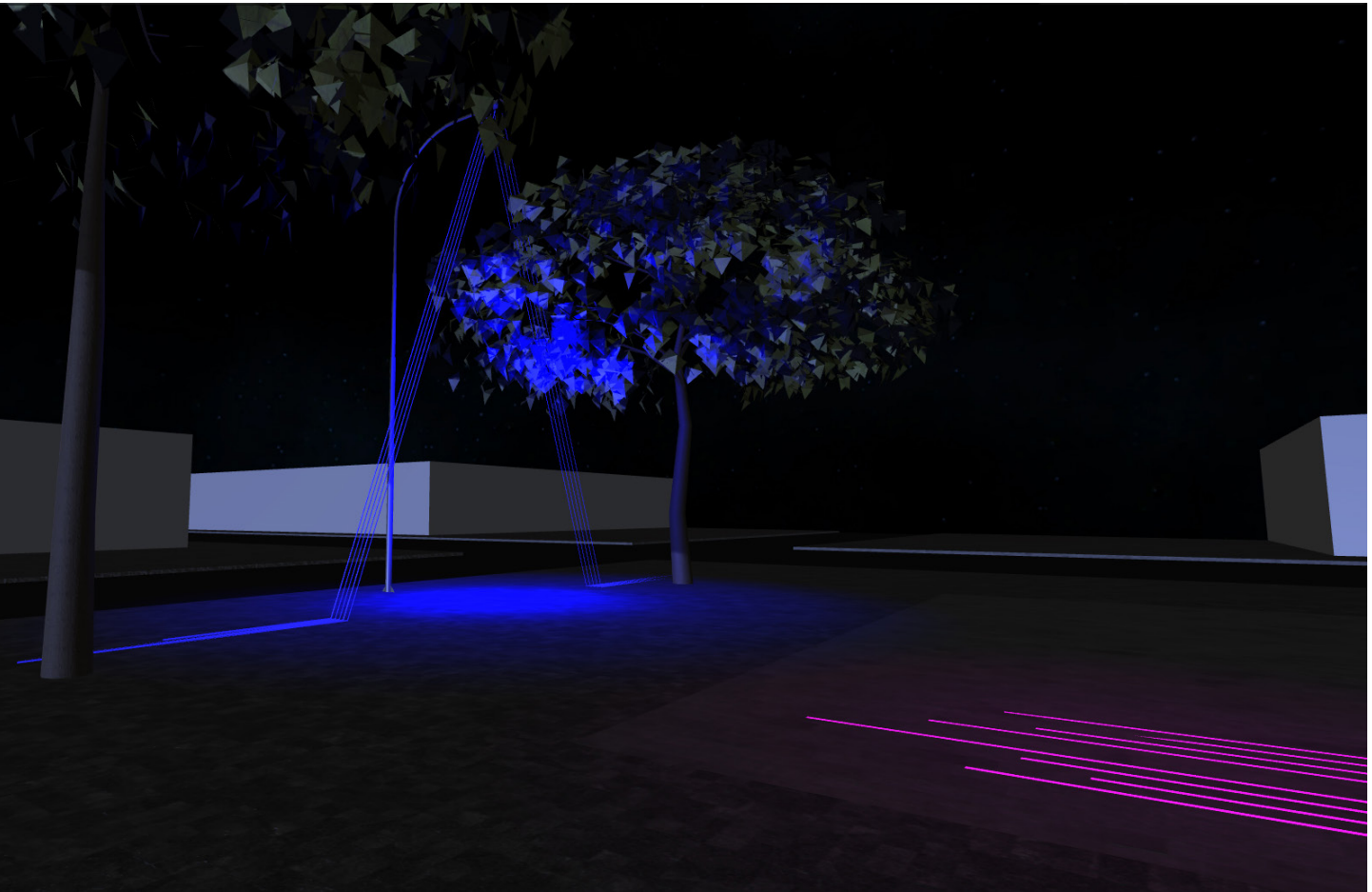


Figure 61. Rendering of Street Lighting Zone 2 by Ursula Eyzaguirre, 2019.

Figure 62. Rendering of Street Lighting Zone 2 by Ursula Eyzaguirre, 2019.

5. CONCLUSIONS



5.1. Rethinking Night Shades

The future of urban lighting is increasingly shaped by a focus on human experience. Human needs are the driver for night lighting design decisions which is the perfect scenario to provide meaningful solutions to the social problems of cities. The direction of lighting is changing from a focus on functional performance to a much more sensitive consideration directly related to human needs and the effects it generates in the population, it is integral lighting solutions within a specific urban context. It is recognized as a fundamental component to promote healthier, safer, attractive and more pleasant urban environments.

In the past, it was believed that a greater amount of light was better; However, this has generated the overexposure that we experience due to the abundance of light in the cities. The paradigm has changed, and now we are faced with rethinking the value of darkness, understanding the different tones of the night and allowing the night to have its own unique set of characters. Technological advances in lighting, technology of things and interactive systems offer immense opportunities for new important approaches in the urban night. The success of lighting in the future, however, will depend on our understanding of the proper use of this technology, it must be a driver for change, it must always react and respond to a clear social or environmental need.

As designers we are responsible for this change and we must take into consideration how to use these complex systems of technologies in an intelligent way, so that they are beneficial for citizens, the environment and the economy. Nowadays the nocturnal activities are increasing, the human activities have inspired the emergence of lighting design and research practices thought for each context. The complex and changing demands of people and cities will be the key factor in designing solutions that work according to the needs and desires of people and different lighting resources without neglecting functionality and sustainability.

The proposal is developed in a long-term context where a greater experimentation of the city is projected that will also allow establishing the new parameters of sustainability, since great energy savings associated with the system will be achieved, which demonstrates the long-term commitment term with the global

agenda. The use of interactive lighting demonstrates its energy efficiency, dynamic control capacity in color and intensity, plays a crucial role in the opening of this new potential use. The proposed system highlights the interactions with the city through an extremely important component such as lighting to transform urban experiences.

In this research, significant relationships have been shown between emotions and interactions with urban lights. Design conditions that generate positive responses from users were identified. Also highlighted were the energy consumption and the reduction of light pollution that could be achieved through interactive designs. Finally, beyond the well-known relationship between lighting and security, the hierarchical relationship between emotions and interaction is valued. The parameters of interactive design with time and minimum levels of illumination can serve as a guide for future designs of lighting systems that can be transformed into efficient, and that improve the mood and affective state of urban residents.

Figure 63. Deployed virtual reality technology in “The Third Age” by Speirs+Major, 2017.

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